A BIRD'S EYE VIEW: IS THE COMMON REMOTELY OPERATED WEAPONS STATION AN IMPROVEMENT OVER A TRADITIONALLY MANNED WEAPON?

A thesis presented to the Faculty of the US Army Command and General Staff College in partial fulfillment of the requirements for the degree

MASTER OF MILITARY ART AND SCIENCE
General Studies

by

KRISTA M. HOFFMAN, MAJ, USA
B.S., US Military Academy, West Point, NY, 1995

Fort Leavenworth, Kansas
2007

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
15-06-2007	Master's Thesis	Aug 2006 - Jun 2007

4. TITLE AND SUBTITLE
A Bird's Eye View: Is the Common Remotely Operated Weapons Station an Improvement Over a Traditionally Manned Weapon?

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Hoffman, Krista M., Major, USA

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Command and General Staff College
ATTN: ATZL-SWD-GD
1 Reynolds Ave.
Ft. Leavenworth, KS 66027-1352

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
This thesis compares a traditional M2 machine gun with an M2 mounted on the Common Remotely Operated Weapon Station (CROWS).CROWS is a remotely operated weapons platform primarily mounted on the Army's M1114 Up-Armored High Mobility Multipurpose Wheeled Vehicle (HMMWV). The problem is whether this state of the art weapon system is an improvement over a traditionally manned weapon in combat. To address the problem the thesis analyzed the benefits of CROWS over an M2, any systemic issues associated with the system, what users thought, and what additional and unique resources CROWS requires. This thesis also analyzed the system's limitations in terms of doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF). The combination of document research and primary source information provide justification that, despite some increased capabilities, CROWS is not an improvement over a traditionally manned weapon in combat at the current time.

15. SUBJECT TERMS
CROWS, Army Materiel Command, PM, contractor, robotics, DOTMLPF, M2, weapons

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified	UU	81	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

MASTER OF MILITARY ART AND SCIENCE
THESIS APPROVAL PAGE

Name of Candidate: MAJ Krista M. Hoffman

Thesis Title: A Bird's Eye View: Is the Common Remotely Operated Weapon Station an Improvement over a Traditionally Manned Weapon?

Approved by:

_____, Thesis Committee Chair
Mr. James B. Martin, Ph.D.

_____, Member
LTC Prisco R. Hernandez, Ph.D.

_____, Member
Mr. Michael E. Weaver, M.A.

Accepted this 15th day of June 2007 by:

_____, Director, Graduate Degree Programs
Robert F. Baumann, Ph.D.

The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the US Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

CERTIFICATION FOR MMAS DISTRIBUTION STATEMENT

1. Certification Date: 15 June 2007

2. Thesis Author: MAJ Krista M. Hoffman

3. Thesis Title: Bird's Eye View: Is the Common Remotely Operated Weapons Station an Improvement over a Traditionally Manned Weapon?

4. Thesis Committee Members: _____

Signatures: _____

_____

5. Distribution Statement: See distribution statements A-X on reverse, then circle appropriate distribution statement letter code below:

(A) B C D E F X SEE EXPLANATION OF CODES (ST 20-10 2006, B-8)

If your thesis does not fit into any of the above categories or is classified, you must coordinate with the classified section at CARL.

6. Justification: Justification is required for any distribution other than described in Distribution Statement A. All or part of a thesis may justify distribution limitation. See limitation justification statements 1-10 on reverse, then list, below, the statement(s) that applies (apply) to your thesis and corresponding chapters/sections and pages. Follow sample format shown below:

EXAMPLE

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
Direct Military Support (10)	/	Chapter 3	/	12
Critical Technology (3)	/	Section 4	/	31
Administrative Operational Use (7)	/	Chapter 2	/	13-32

Fill in limitation justification for your thesis below:

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
	/		/	
	/		/	
	/		/	
	/		/	
	/		/	

7. MMAS Thesis Author's Signature: _____

ABSTRACT

Thesis Title: A Bird's Eye View: Is the Common Remotely Operated Weapon Station an Improvement Over a Traditionally Manned Weapon? by MAJ Krista M. Hoffman, 69 pages.

This thesis compares a traditional M2 machine gun with an M2 mounted on the Common Remotely Operated Weapon Station (CROWS). Enemy tactics in Iraq led the military to develop materiel solutions that will increase force protection, particularly when operating off base and on roadways. CROWS is an example of military innovation designed to increase force protection while maintaining lethality and minimizing collateral damage. CROWS is a remotely operated weapons platform primarily mounted on the Army's M1114 Up-Armored High Mobility Multipurpose Wheeled Vehicle (HMMWV). The problem is whether this state-of-the-art weapon system is an improvement over a traditionally manned weapon in combat. To address the problem the thesis analyzed the benefits of CROWS over an M2, any systemic issues associated with the system, what end-users thought, and what additional and unique resources CROWS requires. This thesis also analyzed the system's limitations in terms of doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF). The combination of document research and primary source information provide justification that, despite some increased capabilities, CROWS is not an improvement over a traditionally manned weapon in combat at the current time.

ACKNOWLEDGMENTS

First, I would like to thank my late father, Martin Hoffman, who taught me the value of an education and that working hard to achieve it was worth every bit of effort. I would also like to thank those who made this thesis possible--the members of my committee, the graduate degree department, and those who provided information for this study. I would especially like to thank Dr. James Martin, my chairman, for the dedication and commitment he shows to his students. Finally, I would like to thank the Soldiers, Sailors, Airmen, and Marines who are using CROWS on the roads of Iraq and those who went before them. You are truly America’s heroes.

TABLE OF CONTENTS

Page

MASTER OF MILITARY ART AND SCIENCE THESIS APPROVAL PAGE ii

CERTIFICATION FOR MMAS DISTRIBUTION STATEMENT iii

ABSTRACT..... iv

ACKNOWLEDGMENTS v

ACRONYMS..... viii

ILLUSTRATIONS x

TABLES xi

CHAPTER 1. INTRODUCTION 1

Background..... 2
Research Questions..... 5
Assumptions..... 6
Definitions of Key Terms 7
Limitations and Delimitations 8
Significance of Study..... 9

CHAPTER 2. LITERATURE REVIEW 11

Primary Sources..... 11
Secondary Sources..... 12
Other Sources..... 16

CHAPTER 3. METHODOLOGY 22

Method of Evaluation 22
Qualitative Methods..... 22
Data Collection Matrix 25

CHAPTER 4. ANALYSIS.....27

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS 57

Conclusions..... 57
Recommendations..... 60

GLOSSARY 63

BIBLIOGRAPHY 64

INITIAL DISTRIBUTION LIST 68

CERTIFICATION FOR MMAS DISTRIBUTION STATEMENT 69

ACRONYMS

AAR	After Action Review
AIT	Advanced Initial Training
AMC	Army Materiel Command
ANCOC	Advanced Non-Commissioned Officer's Course
APG	Aberdeen Proving Ground, Maryland
ARV	Armed Robotic Vehicle
BST	Basic Skills Trainer
CROWS	Common Remotely Operated Weapons Station
C2	Command and Control
CPT	Captain
DA	Department of the Army
DOTMLPF	Doctrine, Organization, Materiel, Leadership and Education, Personnel, and Facilities
EFCS	Electro-Optic Fire Control System
FLIR	Forward-Looking Infrared
FM	Field Manual
GS	General Service Employee
HMMWV	High Mobility Multipurpose Wheeled Vehicle
IED	Improvised Explosive Device
JFCOM	Joint Forces Command
MNC-I	Multi-National Corps-Iraq
MP	Military Police
NCO	Non-Commissioned Officer

NET	New Equipment Training
ODIS	Omni-Directional Inspection System
OIF	Operation Iraqi Freedom
ONS	Operational Needs Statement
ORR	Operational Readiness Rate
PEO	Program Executive Office
PM	Program Manager
RAAS	Robotic Armored Assault System
RDECOM	Research and Development Command
ROI	Recon/Optical Incorporated
SAW	Squad Automatic Weapon
SMA	Sergeant Major of the Army
SPO	Support Operations
TARDEC	Tank-Automotive Research, Development and Engineering Center
TWV	Tactical Wheeled Vehicle
UAV	Unmanned Aerial Vehicle
UGV	Unmanned Ground Vehicle
UMR	Urgent Materiel Release
USAMPS	US Army Military Police School

ILLUSTRATIONS

Page

Figure 1. Main Components of CROWS 2

Figure 2. A Mounted CROWS 3

Figure 3. Operator in an M1114 with the CROWS 4

Figure 4. CROWS Operator's Station 4

Figure 5. Trainees on a CROWS Simulator, Balad, Iraq 36

TABLES

Page

Table 1. Data Collection Matrix 25

Table 2. DOTMLPF Analysis Matrix 53

CHAPTER 1

INTRODUCTION

> To conduct a convoy in safety through an enemy's territory, where it is exposed to attacks either of regular or of partisan troops, is one of the most hazardous operations of war.[1]
>
> D. H. Mahan, *An Elementary Treatise on Advanced-Guard, Out-Post, and Detachment Service of Troops, and the Manner of Posting and Handling Them in Presence of an Enemy*

Enemy tactics in Iraq have led the military to develop materiel solutions intended to increase force protection, particularly when operating off base and on roadways. The Common Remotely Operated Weapons Station (CROWS) is an example of military innovation designed to increase force protection while maintaining lethality and minimizing collateral damage. CROWS is a remotely operated weapons platform currently mounted on the Army's M1114 Up-Armored High Mobility Multipurpose Wheeled Vehicle (HMMWV). CROWS supports heavy and medium crew served weapons, including the M2 and M240 machine guns, the MK-19 grenade launcher, and the M249 squad automatic weapon (SAW).[2]

The purpose of this thesis is to determine if CROWS is an improvement over a traditionally manned weapon. Traditionally manned indicates that a Soldier is manning the weapon from the turret of a tactical wheeled vehicle (TWV). The turret is a rotating weapons platform that is exposed to the surrounding environment.

This thesis compared a traditionally manned M2 machine gun and a CROWS-mounted M2 machine gun in terms of military doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF) in order to determine if

CROWS' state-of-the-art technology is an improvement over a traditionally manned weapon in combat.

Background

CROWS is manufactured by Recon/Optical, Incorporated of Barrington, Illinois. The system is the response to a December 2004 Army Urgent Materiel Release (UMR) in support of OIF.[3] CROWS is a gunner-operated system capable of remotely aiming and firing a suite of crew-served weapons from inside the relative safety of armored vehicles. Figure 1 shows a close-up picture of the CROWS.

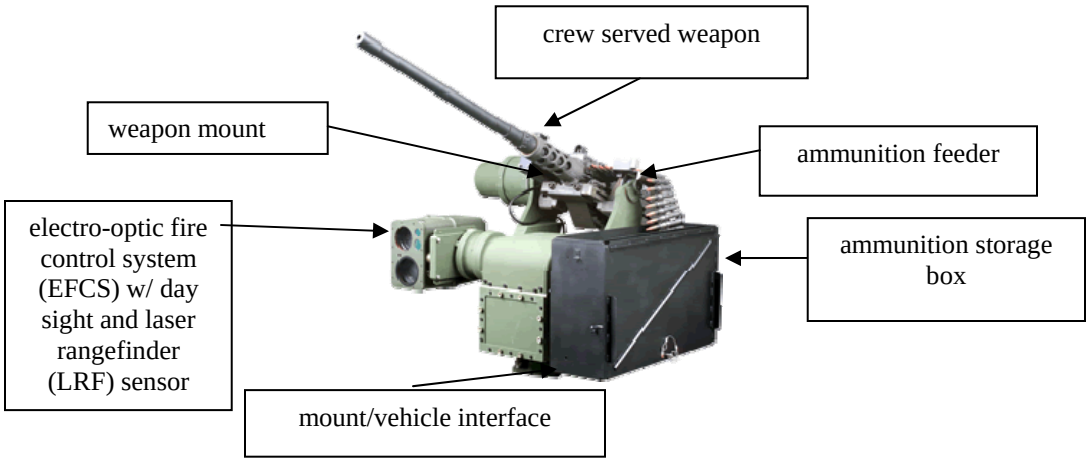

Figure 1. Main Components of CROWS
Photo courtesy of Program Manager (PM) Soldier (image cleared for release and considered in the public domain).

Figure 2 shows CROWS mounted on an Army M1114. CROWS is always mounted on the top center of the vehicle and on the vehicle's turret. CROWS is operated from inside the TWV it is mounted on. The operator controls the mounted weapon

remotely, from the operator's station. Quite simply, this station is his/her seat inside of the vehicle. From the station, the operator can move the weapon and engage targets, much like a video game. Without CROWS, the weapon's operator would man the weapon from the turret and would be exposed to the outside environment from roughly the chest level and above.

Figure 2. A Mounted CROWS
Photo courtesy of PM Soldier (image cleared for release and considered in the public domain).

The main components of the operator's station are the screen and the joystick. The screen displays the image of the CROWS' sight, or what CROWS is "looking at." The joystick maneuvers CROWS and engages targets. The joystick is essentially the control mechanism for the system. Figure 3 shows a CROWS operator in an Army M1114. Figure 4 is an example of a CROWS operator's station.

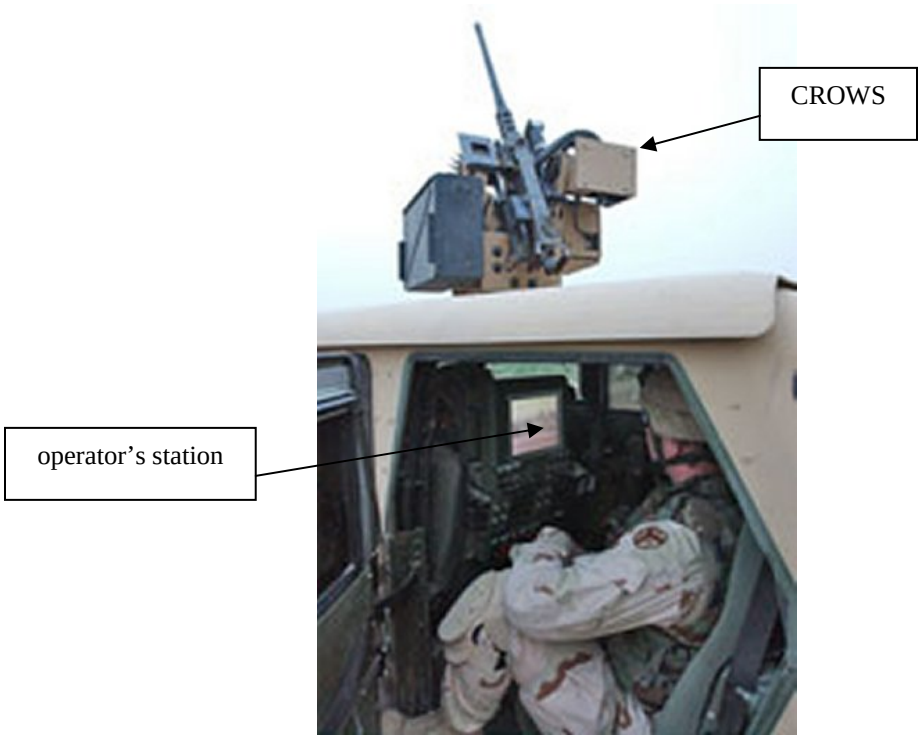

Figure 3. Operator in an M1114 with the CROWS
Photo courtesy of PM Soldier (image cleared for release and considered in the public domain).

Figure 4. CROWS Operator's Station
Photo courtesy of PM Soldier (image cleared for release and considered in the public domain).

The military plans to increase the number of CROWS in Iraq and implement the system on a wider range of tactical vehicle fleets. This will keep more service members inside of their armored vehicles and out of harm's way as they engage the enemy.[4]

Research Questions

The primary research question was: Does CROWS represent an improvement over a manned weapon (M2)? In order to answer this question, secondary questions were developed. Secondary questions are those questions that must be addressed in order to answer the primary question. This thesis used five secondary questions.

The first secondary question was: What are the benefits of CROWS compared to a traditional M2? This question examined whether CROWS increased lethality and force protection, and whether CROWS decreased collateral damage. This question also examined any additional unique capabilities CROWS possessed that a traditional M2 did not.

The next secondary question was: What are the systemic issues associated with CROWS compared to a traditional M2? This question addressed overall problems with CROWS in terms of functionality. The question also measured operational readiness rates (ORRs) and addressed CROWS' limitations.

The third secondary question was: What do end-users think about CROWS? CROWS end-users who also had experience with traditional M2s answered this question. This question addressed the CROWS fielding and training program, and what unique issues CROWS posed for leaders. This question also captured the CROWS characteristics that end-users would maintain and recommend for change.

The fourth secondary question was: What additional resources are required to support CROWS? This question addressed monetary and personnel requirements for CROWS. This question also explored those unique resources required for CROWS forward-based fielding, training, operation, and maintenance.

The final research question was: What are CROWS' limitations across DOTMLPF domains? This question analyzed CROWS across the seven DOTMLPF domains in order to determine the shortfalls associated with the system. This question also addressed how CROWS will fit into DOTMLPF domains in the future.

Assumptions

An assumption is something taken for granted. It is a guess, a presumption.[5] Assumptions must be clearly stated in order to understand how a certain conclusion is drawn. There were several assumptions associated with this thesis: (1) Soldiers interviewed reflected the general opinion of end-users as a whole, (2) personnel were truthful in conveying system shortfalls across DOTMLPF domains, despite having a vested interest in the program, (3) lifecycle costs for CROWS did not significantly change during the time this thesis was prepared, nor did they have significant effects on any DOTMLPF domain, (4) the military will continue to pursue and produce remotely operated weapon stations, like CROWS, for use in current and future operations, (5) CROWS fielding continued directly to units already in Iraq, (6) data and information collected on the M2 reflected similar views for other CROWS weapons systems (MK-19, M240B, and the M249), and (7) AMC's training program for CROWS familiarization and validation did not undergo significant changes during the period of this study.

Definitions of Key Terms

This study compared traditional and CROWS M2 machine guns across the following domains: doctrine, organization, training, materiel, leadership and education, personnel, and facilities (DOTMLPF). Typically, the military conducts a DOTMLPF study when a requirement is identified without a known solution. A DOTMLPF study analyzes solutions across the seven domains to determine what type of solution should be implemented in order to resolve the issue at hand. For example, OIF forces and their leaders raised the issue of increasing force protection during convoys. The military's partial solution to the force protection problem was an addition in materiel, therefore creating and implementing new equipment, like CROWS. The solution to this issue was not through a change or addition to doctrine, facilities, or organization. The solution was an addition in materiel. In this thesis, DOTMLPF was used as a framework for research, not as a problem-solving tool.

Doctrine is defined as those policies which govern or guide the way the military operates.[6] Examples of Army doctrine include field and training manuals, regulations, and mission training plans. Doctrine is important because it conveys accepted, approved military procedures. Organization is, quite simply, how a military element is physically structured. Organization is required for a military element to function, operate, and accomplish its assigned mission.

Field Manual (FM) 7-0, *Training the Force*, defines training as "the process that melds human and materiel resources into [these] required capabilities."[7] Training is what prepares the military to execute wartime missions. Materiel is defined as quantifiable

military property or hardware. Examples of military materiel include ammunition and equipment, like the M2 machine gun and CROWS.

Leadership and education have different definitions, but are considered one DOTMLPF domain because of their relation to one another. FM 6-22, *Army Leadership*, defines leadership as "the process of influencing people by providing purpose, direction, and motivation while operating to accomplish the mission and improving the organization."[8] Education indicates the level to which the military passes along knowledge or skills.

Personnel are those humans comprising the military, to include their knowledge, skills, abilities, and competencies.[9] Facilities includes infrastructure and activities that support military operations. Examples of facilities include buildings, runways, roads, and other infrastructure.[10] Facilities is different from other DOTMLPF domains in that no two elements have exactly the same facilities because they vary by location. However, facilities can have a common baseline--their capabilities.

Limitations and Delimitations

Limitations are gaps in research that are beyond the researcher's control. Limitations are important because they have the potential to influence results and conclusions. This thesis had several limitations: (1) CROWS was a relatively new system and there is little published information, (2) most publications about CROWS are promotional in nature and primarily focused on positive aspects and feedback, (3) dispersed end-user population, particularly after redeployment, (4) most personnel are unfamiliar with CROWS because of its limited numbers and location of use (Iraq only).

Delimitations are boundaries the researcher imposes on the study. Delimitations are critical in order to focus research on answering the research questions. This thesis had several delimitations: (1) research was limited to the M2 machine gun and did not address other CROWS-mounted weapon systems, (2) interviews were conducted with end-users who had already completed AMC's CROWS training and fielding program and had experience with the system from January 2005 and on, (3) recurring/systemic problems, limitations, problems in functionality, and the things end-users would change/keep was limited to the top three, respectively, in each category, (4) ORRs were from January 2005 and on, (5) monetary costs required for the CROWS did address research and development costs, (6) advantages/disadvantages were assessed using a qualitative approach; they did not compare quantitative data between the CROWS and a traditional M2, (7) only published Army doctrine was considered, (8) only DOTMLPF domains were considered in the analysis, and (9) end-users providing feedback had experience with a traditional M2.

Significance of Study

This study is significant for two primary reasons. First, remotely operated weapons systems are here to stay. Systems like CROWS and other robotics are a permanent part of the military. This study stimulated reader's thinking about and addressing the issue of replacing humans in combat. Second, this study addressed shortfalls of implementing robotics, with CROWS as the example, across DOTMLPF domains so that issues and gaps can be addressed, allowing the military to employ robotics for maximum benefit.

In summary, CROWS is one of the military's many materiel solutions for increasing force protection in Iraq. As military technology progresses, CROWS and other remotely operated systems will have a permanent place on the battlefield. These systems, along with traditional weapons, are addressed in chapter 2.

---

[1]D. H. Mahan, *An Elementary Treatise on Advanced-Guard, Out-Post, and Detachment Service of Troops, and the Manner of Posting and Handling Them in Presence of an Enemy* (New York: John Wiley, 1861), paragraph 419.

[2]John Pike, *XM101 Common Remotely Operated Weapon Station (CROWS)* (Global Security.Org, 2005, accessed 8 September 2006); [Online document]; available from http://www.globalsecurity.org/military/systems/ground/m101-crows.htm; Internet.

[3]Ibid.

[4] House of Representatives, *National Defense Authorization Act for Fiscal Year 2006*, 109th Cong. 1st sess., 2005 House Report 109-360.

[5]*Random House Webster's Unabridged Dictionary* (2005), s.v. "assumption."

[6]Joint Forces Command, *Understanding the Seven Components of DOTMLPF* (Norfolk, VA: Joint Forces Command, 2006).

[7]Department of the Army, FM 7-0, *Training the Force* (Washington, DC: Government Printing Office, May 2004), preface.

[8]Department of the Army, FM6-22, *Army Leadership* (Washington, DC: Government Printing Office, October 2006), 1-2.

[9]Joint Forces Command, *Understanding the Seven Components of DOTMLPF* (Norfolk, VA: Joint Forces Command, 2006).

[10]Ibid.

CHAPTER 2

LITERATURE REVIEW

The purpose of a literature review is to identify and analyze literature on a particular topic in order to identify trends and gaps in information. This literature review summarizes research on the M2 machine gun and CROWS. This literature review also summarizes research on remotely operated systems in order to put the M2 and CROWS topics in perspective with the "big picture." This review divided literature into three categories: primary sources, secondary sources, and other sources.

Primary Sources

Primary sources are first-hand sources of information. Primary sources have not been analyzed or interpreted by an outside element. The primary sources used for this study include after action reviews (AARs).

After Action Reviews (AARs) were a valuable primary source used in the research process. AARs are a key primary source because they outline the CROWS' performance after a combat patrol or mission. Aberdeen Proving Ground Test Center's AAR documentation on the confirmation test of CROWS provided detailed information on in-theater combat performance of CROWS. This document served as a lengthy, in-depth AAR which included a wide range of observations by end-users. AARs received by the OIF CROWS fielding site were also beneficial, although feedback focused primarily on initial fielding and training. AARs received by CROWS end-users with actual combat experience primarily focused on the functionality of the system, rather than actual performance in a combat environment.

Program Executive Office (PEO) Soldier's "Soldier Feedback Advances Remote Weapons Stations" is a comprehensive AAR that captured data and information from convoy operations in Iraq. PEO Soldier is the Army organization that interfaces with civilian industry to develop and field equipment to the Army in support of assigned missions.[1] This AAR discussed initial requirements, capabilities, applications, and Soldier feedback for two remotely operated weapon systems. The two systems were CROWS and the M151 Protector Remote Weapon System, which is mounted on the Army's Stryker vehicle.

Secondary Sources

Secondary sources are sources of information that have gone through some form of interpretation by the author. Secondary sources usually describe a topic in order to convey a certain message or persuade the reader into thinking a certain way. Secondary sources used for this thesis include books, articles, scholarly publications/theses, and military doctrine.

Books were a valuable source of information, but the information they provided was limited to the M2 machine gun and other unmanned robotics used in military operations. Many articles were written on CROWS, but up to the time of this thesis's publication, no books. Although it does not specifically address CROWS and is somewhat outdated, the book Robotics: Applications and Social Implications did address the use of robotics in various fields, to include the military. The book also addressed some of the personnel, training, educational, and organizational implications of machines replacing humans, which is applicable to the CROWS replacing a human behind a weapon system. The book Technology in War: The Impact of Science on Weapon

Development and Modern Battle was also quite outdated, but did provide solid insight on how science and technology influence various areas of the military, primarily personnel and materiel.

Circle the Wagons: The History of US Army Convoy Security was an excellent historical account of convoy security from the early nineteenth century to operations in Iraq. This work addressed the unique difficulties convoys have faced in terms of force protection throughout history. This work also provided a historical summary of weapons systems used by convoys, as well as materiel solutions the Army has used to increase convoy security and force protection.

There are many articles on the subject of both CROWS and other robotics used in support of military operations. Most CROWS articles are informative in nature, like PM Soldier's "Common Remotely Operated Weapon Station-Lightning," Defense Acquisition and Technology's "Soldier Tester at Aberdeen Test Center Helps Army Develop Common Remotely Operated Weapons Station," Defend America's "CROWS Keeps Gunners Out of Harm's Way," and Air Force Link's "CROWS Gets Airmen Out of the Turret." These articles addressed topics, like the use of CROWS' specifications, ability to detect improvised explosive devices (IEDs) using thermal imagery, and the CROWS-Lightning, a lighter version of the system designed to reduce stress on the TWV it is mounted on.

"Tank Unit Fields Remote Weapon Systems" provides information out of Fort Bliss, Texas regarding Company D, 2nd Battalion, 12th Cavalry Regiment. The article was important because this unit was the first US-based unit to receive CROWS. It also marked the first CROWS fielding on the M1 Abrams tank.[2] Although this fielding is both

new and experimental, initial feedback was discussed in terms of tank gunnery performance, engagement accuracy, and leader feedback. The leader feedback discussed in this article is what makes it significant.

Fort Benning's *The Bayonette* covered CROWS in "Another Kind of 'Birds-Eye' View: Army Deploys CROWS to Iraq." In this article, Soldier feedback is captured from night operations al-Karama, Iraq. Feedback highlighted CROWS' thermal ability to identify IEDs. The article also discussed how systems like CROWS could change the way leaders employ units against an enemy.[3]

Business Week's "Evening the Odds in Guerilla Warfare" discussed the Army's acquisition interface with civilian corporations developing new technology for the military. This article focused on CROWS, providing information on system delivery timelines, modifications based on end-user feedback, and how systems, like CROWS, could have a significant impact on shaping the Army. This article also addressed other civilian-developed weapons for use by OIF forces in response to the guerrilla tactics seen in Iraq.

The British Broadcasting Company's (BBC's) "U.S. Plans 'Robot Troops' for Iraq" provided information on the Army's plans to implement a robot fighter called the Special Weapons Observation Reconnaissance Detection System (SWORDS). Like CROWS, this system relies on cameras and its human operator in order to open fire. SWORDS can be fitted with the M240 machine gun or M249 squad automatic weapon rifle and uses a joystick and screen combination as part of control unit.[4] This article identified the positive characteristics of robot-armed machine guns: greater accuracy, weapon stability, minimal engagement errors, and its familiar video game style.

Discovery News, an element of the Discovery Channel Network, describes various remotely-operated UAVs used by US Marines fighting in Iraq in "New Combat Robot Prepares for Duty." In this article, a senior engineer from the Boeing Corporation highlights advanced research that extends beyond aerial systems to ground systems. According to the engineer, the civilian-military partnership goal is to integrate advanced technology with existing military systems and organizations.[5]

Scholarly publications and theses were another secondary source used. The US Army's Tank-Automotive Research, Development and Engineering Center's (TARDEC) published "Robots at War: Experiences in Iraq and Afghanistan." This scholarly work was written by three engineers working in TARDEC's Robotics Mobility Lab. This publication provided an in-depth study of the Omni-Directional Inspection System (ODIS) robot. This system is a remotely operated robot that inspects the under-belly of vehicles in Iraq and Afghanistan. Like CROWS, its purpose is to increase force protection. It is also remarkably similar to CROWS in that it has a visual camera and an operator control unit that includes a screen, a joystick, and a control box.[6] This work provided detailed information on ODIS operation, performance, and ongoing research-developments. Equally important is the perspective this publication provided on robotics performance in Iraq and Afghanistan.

"Expert Systems and Robotics" is another scholarly work that discussed robotics applications in the military. This work focused on the use of robotics in military intelligence operations. The author presented a focused argument that supports the use of robotics and expert systems in artificial intelligence.

At the time this thesis was published, there was no published military doctrine for CROWS or other similar remotely operated weapon systems. Field Manual (FM) 3-22.65, *Browning Machine Gun, Caliber .50 HB, M2*, is the Army's primary manual for the M2 machine gun. This manual described all aspects of training and technical information on the M2. The *Soldier's Manual of Common Tasks-Skill Levels 1* and *2-4* provided training procedures and standards for those tasks associated with the operation, use, and maintenance of the M2. Tasks included M2 use during convoy operations.

FM 4-01.011, *Unit Movement Operations*, FM 55-30, *Army Motor Transport Units and Operations*, and FM 19-25, *Military Police Traffic Operations* were valuable resources for describing military doctrine for convoy operations and security. FM 4-01.011 provided overarching guidance for convoy operations before, during, and after execution. FM 55-30 concentrated on Transportation Unit convoy operations, but did provide a significant amount of information on convoy security. FM 19-25 provided MP-specific information, primarily focusing on their role in convoy security operations.

FM 3-04.15, *Multi-Service Tactics, Techniques and Procedures for the Tactical Employment of Unmanned Aircraft Systems* is the FM published on the implementation of unmanned weapon systems at the tactical level. This publication was published in August 2006. This publication is significant because it lays the foundation for future military doctrine for robotics and unmanned systems. One may predict that doctrine discussing unmanned land-based systems is forthcoming.

Other Sources

Government documents comprised a large portion of the secondary sources used in this study. Documents, like the *House Report 109-360,* provided detailed monetary

information on CROWS as reviewed and approved by Congress. This information was useful in analyzing the second and third order effects of fielding CROWS, including the associated facility and materiel costs. The US Army War College Strategic Studies Institute's publication "Land Warfare in the 21st Century" did not specifically address CROWS or thermal sights, but the report did discuss several leadership issues associated with the implementation of advanced technology and materiel that 21st century leaders will likely face.

US Army Development Test Command's 2002 *Test Record for the Common Remotely Operated Weapons Station* provided detailed results on CROWS testing on the Army's Armored Security Vehicle (ASV). The ASV is a heavily armored vehicle fielded directly to Iraq for use by MPs during convoy security operations. This report outlined objectives, methods, and qualitative and quantitative test results. This report particularly highlighted CROWS limitations and shortfalls.

The US Army Tank-automotive and Armaments Command's (TACOM) Safety of Use Message (SOUM), dated 8 March 2007 was published Army-wide through official safety and command channels. TACOM is the US Army's life-cycle command responsible for the providing and sustaining the Army's ground and armament systems. TACOM works in partnership with Project Manager (PM) organizations, to include PM Soldier, the PM organization responsible for CROWS fielding to Soldiers. SOUMS are messages released for immediate attention. SOUMS describe emergency safety concerns identified in testing or in the field. SOUMS describe the issue and direct immediate, mandatory corrective measures to be taken. This SOUM announced that loss to power drives may cause CROWS to move against the operator's commands, potentially

resulting in firing at an unintentional target. According to the message, there were two known instances of unintentional targeting, one of which resulted in physical injury to friendly forces.[7]

Various presentations were also a valuable group of secondary sources. The 2005 CROWS presentation given at the National Defense Industrial Association's Small Arms Systems Symposium was particularly informative. This presentation provided detailed information on CROWS specifications, as well as achieved performance data (qualitative and quantitative). The presentation also addressed CROWS issues with respect to force protection, lethality, end-user situational awareness. Finally, the presentation addressed the ability to develop a CROWS system that is lighter, smaller, and more affordable, while still maintaining all of its capabilities.

The Sergeant Major of the Army (SMA), SMA Kenneth O. Preston, discussed the use of new technology and equipment in support of Soldiers in Iraq at the 2006 Association of the United States Army (AUSA) Annual Conference. While addressing the Resolutions Committee, SMA Preston discussed new equipment fielding in support of Soldiers in Iraq. SMA spoke specifically of CROWS, highlighting its ability to engage targets from the inside of an armored-protected vehicle.[8] SMA Preston's remarks stressed the importance the Army's senior leadership assigns to advanced technology like CROWS.

The Association for Unmanned Vehicle Systems International's unmanned systems online presentation provided an extensive overview of military robotics employed in Iraq. The presentation described many unmanned aerial vehicles (UAVs) and unmanned ground vehicles (UGVs). Two of the UGVs discussed are very similar to

CROWS, the Talon Robot and the iRobot Packbot. The Talon is a UGV used for reconnaissance and weapons delivery. Like CROWS, the Talon has a remotely-controlled camera and an operator control unit, which is used for vehicle positioning and operation.[9] The Packbot is also used for reconnaissance, but also has law enforcement and explosive ordnance disposal capabilities.[10]

Another group of secondary sources were informational websites. PEO Soldier's website, www.peosoldier.army.mil provided a comprehensive overview of current CROWS information. The most useful information provides in-depth details on performance characteristics and the system's physical specifications.

The FMSWeb website provided information from the Army Authorization Document System (TAADS). TAADS stores current organizational structure, personnel and equipment authorization information for all Army units/organizations. Users are able to pull up any organization's personnel and equipment authorizations and sort the data as desired. FMSWeb was an excellent resource for determining the personnel and equipment authorizations of units who have CROWS in order to analyze differences and/or limitations.

America's Army website, available through Army Knowledge Online (AKO) provided information on the CROWS basic skills trainer (BST). The BST will allow Soldiers to train on an actual CROWS in a classroom environment. This system is being developed by PM offices and will be used by CONUS-based units. This information is important because it indicates that the Army is investing CROWS training beyond Iraq. It also indicates that CROWS is not a fleeting system that will disappear from the Army's inventory after OIF.

The final group of secondary sources used was briefing documents. Joint Forces Command's (JFCOM) "Leveraging DOTMLPF" publication provided excellent information about DOTMLPF analysis. This publication defined all DOTMLPF domains and explained how a DOTMLPF analysis can be used as a diagnostic tool or an analytical tool.

The publications described in this chapter represent the large body of literature available on CROWS, the M2 machine gun, and the military's use of remotely operated systems. They were selected because they identified trends and gaps in information. They also provided information related to the seven DOTMLPF domains. Chapter three describes the framework for how the publications described in this chapter, and primary data, were combined to conduct an analysis.

America's Army's *Public Game and Training Applications* provides information on how the Army is leveraging computer games into weapons prototyping. This document addresses the development, specifications, and capabilities of the CROWS Basic Skills Trainer (BST). This document is significant because it explains how CROWS is being incorporated into CONUS-based training. It also signifies the Army's commitment to the continuation and further development of remotely operated weapons systems.

Briefing slides used in the 1st Battalion, 402nd Field Support Brigade's weekly support operations meeting were also beneficial. These slides depicted how CROWS ORRs were captured and briefed above the unit level. The information provided on the slides was the information forwarded to CONUS-based PM offices and the ROI Company in order to capture information and identify trends.

The review of literature discussed in this chapter highlight many of the significant sources currently available on the subject of CROWS, the M2 machine gun, and unmanned robotics used in military operations. The methodology that will be used in analyzing these sources are discussed in chapter 3.

---

[1] PEO Soldier Public Affairs Office, PEO Soldier: The Heart of the Army-Geared to Go (Fort Belvoir: PEO Soldier, 2006).

[2] Paula Taylor "Tank Unit Fields Remote Weapon System," Fort Bliss, TX: Army News Release, 2006, accessed 29 September 2006; [Article online]; available from http://www.roi.bourns.com/News/Default.asp; Internet.

[3] Nikki St. Amant, "Another Kind of 'Birds-Eye' View: Army Deploys CROWS to Iraq," *The Bayonette*,7 January 2005, 2.

[4] BBC News, US Plans 'Robot Troops' for Iraq, United Kingdom: BBC news, 2005, accessed 12 December 2006; [Document online]; available from http://news.bbc.co.uk/1/hi/world/americas/4199935.stm; Internet.

[5] Jennifer Viegas, New Combat Robot Prepares for Duty, United Kingdom: Discovery News, 11 November 2005, accessed 12 December 2006; [Article online]; available from http://dsc.discovery.com/news/briefs/20041108/planebot.html; Internet.

[6] W. J. Smuda, L. Freiburger, and G. Gerhart, Robots at War – Experiences in Iraq and Afghanistan (Research Development, and Engineering Center, TACOM. Warren, MI, December 2004), 1.1-1.3.

[7] US Army Tand-automotive and Armaments Command. "Safety of Use Message 07-001," Warren, MI: TACOM, 8 March 2007, 1.

[8] Remarks of Kenneth O. Preston, remarks to the Resolutions Committee, AUSA Conference, Washington, D.C., 6 October 2006.

[9] Association for Unmanned Vehicle Systems International, US Military Robots Employed in Iraqi War (Arlington: AUVSI, 2003), 1.

[10] Ibid.

CHAPTER 3

METHODOLOGY

The purpose of this chapter is to outline the research methodology used to answer the primary and secondary research questions. This chapter defines the method of evaluation used in this thesis. This chapter also addresses the advantages and disadvantages associated with each research method.

Method of Evaluation

The method of evaluation used in this thesis is a qualitative analysis. Qualitative analysis compared a CROWS M2 with a traditional M2 across all DOTMLPF domains using as much detailed information as possible. Qualitative data collected for this thesis was carefully examined in order to determine how data answered the primary and secondary questions. Although the qualitative data collected was very detailed in nature, there were some potential shortfalls. Qualitative data is often not as concise and straight-forward as quantitative data. Data may be biased based on the experiences or pre-conceived notions of the provider and/or interpreter. Qualitative data can also take a considerable amount of time to analyze and draw conclusions from. In order to mitigate these potential shortfalls, the interpreter must ensure that analysis is objective, fair, and not influenced by personal feelings.

Qualitative Methods

The first method used was personal observations. Observations are first-hand accounts of the topic studied.[1] The author of this thesis used personal observations while serving as the S-3 Operations Officer for the battalion having overall C2 for the CROWS

fielding and training program in Iraq, supporting OIF. Observations were captured from both a training perspective and as an end-user. The author attended the forty-hour new equipment training block in Iraq and participated in convoy operations using CROWS. Observations were beneficial because they provided first-hand exposure to a wide-range of events and allowed the observer to put data in a broader context. Unfortunately, they also had several potential disadvantages. Observations can be influenced by the observer bias and are open to observer perception and interpretation. Observations may also threaten the privacy of those being observed.[2] The observer was able to mitigate these disadvantages by remaining objective and blending in as a CROWS end-user.

The next method used was interviews. Interviews were either structured or in-depth. Structured interviews followed a methodical format, while in-depth interviews were less structured and focused on guided questions leading to open dialogue. Interviews were conducted with individuals having first-hand experience with both CROWS and traditional M2s. Individuals interviewed included end-users and those individuals directly responsible for CROWS fielding and training. Interview responses varied significantly, primarily based on the disparity in end-user experiences. Feedback from end-users just completing CROWS fielding varied dramatically from those who had months of operational experience. In-depth interviews, in particular, had the potential to provide excessive feedback, often not pertinent to the analysis.

The next technique used was a focus group. A focus group is an interview with a group of individuals possessing personal experiences and observations.[3] The focus group was beneficial because it provided a non-threatening environment that promoted open dialogue. The focus group widened data collection by stimulating group dialogue based

on the feedback of other members of the group. The disadvantage of the focus group was that it had the potential to turn into a venting session. To mitigate this occurrence, the interviewer redirected the group to pertinent issues and topics. Members of the focus group were CROWS and traditional M2 end-users who recently completed one-year combat tours in Iraq.

The next technique used was document study. Document study included identifying, reading, and analyzing data from primary sources. Document study was conducted using the AARs described in Chapter 2. Document study was beneficial because information was readily available and fairly easy to obtain. However, document study also had disadvantages. Because CROWS and other robotic systems are new concepts to the military, AARs were somewhat limited and often incomplete, particularly in terms of end-user feedback and future implications. The AARs used in this thesis were limited because they lacked significant feedback on actual combat performance. The AARs captured two types of end-user feedback.

The first type of feedback was captured immediately after the fielding and training program culminated, known as new equipment fielding. This feedback was beneficial for identifying strengths and weaknesses of the training program, but those providing input lacked operational experience. The second type of feedback captured feedback sent voluntarily to the CROWS fielding team after end-users had more experience with CROWS in a tactical environment. This feedback was certainly beneficial for identifying system strengths and weaknesses, but it captured a very small population of end-users and lacked details on actual enemy engagement.

The final method used was the key informant. A key informant is an individual whose background is directly related to the topic being researched. A key informant often has direct knowledge of personnel involved in the study, (such as those being interviewed), and has direct access to pertinent topic information.[4] Key informants used in this analysis included the CROWS OIF training and fielding site managers. Key informants were not only credible sources; they helped build the relationship between the author and many of the end-users interviewed. The drawback to key informants was that they were extremely busy individuals. They also had the tendency to be biased toward positive aspects of CROWS.

Data Collection Matrix

Table 1 is the data collection matrix used for this thesis. Table 1 depicts the secondary questions, the collection method used to answer the questions, and the respective data sources.

Table 1. Data Collection Matrix

Secondary Question	**Data Collection Method**	**Data Source**
What are the benefits of CROWS compared to a traditional M2?	Observations, interviews, focus group, document study, key informant	Personal observations, end-users, publications
What are the systemic issues associated with CROWS compared to a traditional M2?	Observations, interviews, focus group, document study, key informant	End-users, publications
What do end-users think about CROWS?	Observations, interviews, focus group, key informant	End-users, AARs, publications
What resources (beyond a traditional M2) are required to support CROWS?	Document study, interviews, key informant	End-users, publications

In summary, this chapter summarized the qualitative methods of research used in this thesis. Chapter 4 will describe the findings and provide information across DOTMLPF domains to ultimately answer the primary research question, is CROWS is an improvement over a traditionally manned weapon?

---

[1] Joy Frechtling and Laure Sharp-Westat, eds., *User Friendly for Mixed Method Evaluations* (Washington, DC: National Science Foundation, 1997); accessed 12 December 2006; [Document online]; available from http://www.nsf.gov/pubs/1997/nsf97153/; Internet, part II, chap.3.

[2] Ibid.

[3] Idid.

[4] Ibid.

CHAPTER 4

ANALYSIS

The purpose of this chapter is to integrate those resources discussed in the literature review with the methodology in order to answer the primary research question: Does CROWS represent an improvement over a traditionally manned weapon (M2)? This chapter answers all research questions starting with the tertiary and ending with the primary question. Answers to the secondary questions will be summarized at the end of each respective area. Answers will then be compiled at the end of the chapter in order to answer the primary research question.

A critical topic that must be analyzed in order to answer the primary question is what, if any, are the benefits of CROWS compared to a traditional M2 machine gun. A critical piece of information needed for this analysis is whether CROWS increases lethality. It is difficult to determine if CROWS engages a greater number of targets in battle, or whether engagements are more lethal with CROWS. However, initial CROWS testing by the US Army Development Test Command indicated that CROWS had an increased first-round hit probability.[1] Personnel from the PM office indicate that when all CROWS features are use properly, the weapon is 98% accurate.[2] In addition, CROWS possesses five distinct capabilities that can potentially make it more lethal than a traditional M2.

First, CROWS can view a target independent of weapon elevation. This capability is made possible by a system of cameras and high-powered sensors.[3] This is not the case with a traditional M2. With a traditional M2, the gunner must have the weapon elevated at the level of the target in order to see the target through the weapon's sight. Having the

capability to view a target despite weapon elevation increases lethality because the gunner has a constant line of sight on a target at all times, despite its height.

Second, CROWS possesses a precise stabilization and weapon recoil control mechanism. This mechanism resists weapon kickback experienced during firing. The mechanism also resists weapon movement caused by rough terrain.[4] Weapon recoil and rough terrain can cause a traditional weapon to jerk or move suddenly, decreasing the probability of successfully engaging a target. For this reason, CROWS' stabilization mechanisms increase lethality.

Third, CROWS possesses a manual firing capability in the event of a malfunction. When operated manually, the CROWS' weapon mount allows increased weapon stability over a traditional pintle weapon mount.[5] This capability increases lethality for the same reasons as CROWS' precise stabilization and weapon recoil control mechanism--weapon stability. Fourth, CROWS has the capability to zoom-in on a target. This capability provides the gunner with a close-up view, increasing the probability of positively engaging the intended target.

Finally, CROWS is capable of first-burst target engagement. First-burst engagement is a term used to indicate that CROWS will engage a vehicle-sized target at least once in the first three to five round burst. First-burst engagement is possible through enhanced fire control software that increases accuracy.[6] A traditional M2 does not have fire control software, and is therefore not as capable of achieving first-burst target engagement, making CROWS more lethal.

Another critical piece of information is whether CROWS increases force protection. It obviously does as a primary benefit of CROWS is to get the gunner out of

the turret and into an armored vehicle, providing ballistic protection against sniper fire and mine blasts.[7] But CROWS increases force protection in other ways.

First, CROWS prevents gunner ejection from the turret in the event of an accident, IED explosion, or vehicle rollover. Second, the FLIR enables the gunner to detect hidden IEDs at a distance, even when hidden or buried.[8] The FLIR, along with CROWS' ability to traverse 360 degrees and elevate from -20 to 60 degrees, enables the gunner to engage targets at a greater distance. In doing so, a convoy has a greater chance of avoiding a potential ambush, firefight, or IED.[9] End-users indicate that CROWS' FLIR, traverse, and elevation capabilities also increase battle space awareness, providing the gunner with the ability to better protect and defend the convoy.[10] CROWS ability to engage targets from the inside of an armored vehicle, coupled by advanced capabilities, increases force protection.

Like lethality and force protection, another important piece of information is determining whether CROWS decreases collateral damage in a combat environment. Collateral damage is the unintentional damage to facilities, equipment, or personnel as a result of military operations against an enemy.[11] Measuring a decrease or increase in collateral damage is a difficult process due to the nature of war. However, collateral damage may increase with CROWS because the system can engage targets more accurately at a greater distance. First, engaging targets at a greater distance increases the likelihood of noncombatants unknowingly becoming involved in combat operation. Second, an inexperienced, ambitious CROWS gunner may be more likely to engage non-hostile targets. Third, the fact that a CROWS operator does not have the same external stimuli that an exposed gunner has may also lead to engaging non-hostile targets. This is

because a CROWS gunner does not see, hear, and feel what an exposed gunner can. For example, a CROWS gunner is not likely to a potential target's verbal indication of a surrender. They may also not see beyond the narrow scope of the proposed target to see aspects of the surrounding area that may impact whether the target is actually hostile.

Conversely, CROWS is able to engage targets at a greater distance because of advanced target acquisition technology, which potentially decreases collateral damage through precision targeting. The FLIR also potentially decreases collateral damage by providing advanced visual capabilities during conditions of limited visibility. CROWS' ability to program no-fire zones, known as Firing Inhibit Zones (FIZ), can also decrease collateral damage. This ability is programmed in through a specific screen on the gunner's station. FIZ provides a continuous range of azimuths and elevations through which CROWS will not fire.[12]

Finally, the safety of use message (SOUM) published by TACOM in early March 2007 leads one to question whether CROWS actually increases force protection. According to this SOUM, there was one instance of a Soldier being struck with shrapnel in the leg.[13] Although the injury did not affect the CROWS operator, it did affect friendly forces. Incidents of unintentional fire certainly do not increase force protection.

A final piece of information critical to determining CROWS' benefits is analyzing those additional, unique capabilities that CROWS possesses that a traditional M2 does not. CROWS has many unique capabilities that distinguish it from a traditional M2. First, CROWS has a FLIR capability. Many of the FLIR's capabilities were discussed earlier in this chapter, but the major advantages are its ability to detect heat/thermal emissions, which provide increased visual capabilities, despite darkness and adverse weather. The

FLIR is also built in to CROWS and requires no additional resources to activate. A traditional M2 has no internal ability to detect heat/thermal emissions and requires an external AN/TVS-5 night vision sight be attached for night and adverse weather visibility. According to end users, the FLIR produces a higher quality image than the AN/TVS-5.[14]

Second, CROWS possesses environmental readiness, meaning that it is mission capable in adverse environmental conditions, like poor weather. It is as effective in adverse weather as under ideal conditions. This may not be true of a traditional M2. The gunner's ability to engage a target is potentially affected by the environment and weather. CROWS is also sand, salt, rain, and dust hardened. Third, CROWS itself is armor plated. A traditional M2 may or may not be protected by ballistic shields around the turret, depending on the assets of the owning unit.

Finally, CROWS possesses a sector surveillance scanning capability that is programmable much like the FIZ capability. Sector surveillance scanning provides continuous target scanning in a specified area likely to contain an enemy threat. This ability is systematic, continuous, and does not tire like a human may behind a traditional weapon.

In summary, CROWS has several benefits over a traditional M2. CROWS provides increased lethality, primarily due to its ability to view a target regardless of weapon elevation, its precise stabilization and weapon recoil control mechanism, and its manual firing and first-burst engagement capabilities. CROWS increases force protection in several ways. First, the system keeps the gunner inside of an armored vehicle, preventing gunner ejection during accidents and vehicle roll-overs. CROWS' FLIR

capability also increases force protection by providing increased visuals of potential enemy activity and hazards. Unfortunately, malfunctions in the system have caused physical injury to friendly forces, which may negate the other force protection benefits CROWS provides. Finally, CROWS possesses unique capabilities that a traditional M2 does not, to include its FLIR capability, environmental readiness, and sector surveillance scanning capability.

A second topic of analysis needed to answer the primary research question is determining what systemic issues, if any, exist with CROWS. In doing so, the operational readiness rates (ORRs) are analyzed. Above the user level, 1st Battalion of the 402nd Field Support Brigade in Iraq tracks ORRs through the CROWS fielding and training site, since they are the agency that supports CROWS maintenance beyond unit capabilities. ORRs are briefed at weekly support operations maintenance meeting and indicate the number of systems non-mission capable (NMC) by serial number. Briefing slides also indicate the fault(s), the action being taken to correct the fault, the location of the NMC system, and, if applicable, the status of the required part. Readiness information is provided to the CROWS fielding and training site by owning units, then compiled for submission to AMC and PM agencies. During the month of May 2006, the CROWS ORR was 96% (cumulative). According to PM personnel in Iraq, this is typical.[15]

Another topic that was analyzed was determining CROWS' major limitations. Research indicated that the predominant limitation associated with CROWS was decreased situational awareness. Decreased situational awareness is caused by limited exposure to external stimuli and limited gunner field of view.[16]

Although CROWS provides the gunner with the advantage of increased protection, that protection limits exposure to external stimuli. The author's personal experiences indicate that armor plating on vehicles nearly silences sounds from the external environment. These sounds, which can include human voices, gunfire, and even the sound of a small IED explosion, are often indicators of enemy activity. In the Army's M1114 vehicle, in particular, there is limited plating on the vehicle's underbelly. A lack of plating on the underbelly amplifies the sound of the vehicle's engine, decreasing the gunner's ability to hear external stimuli even more.

CROWS' cameras provide increased capability, to include the ability to zoom-in on targets and enhanced visibility during periods of limited visibility. However, CROWS cameras do not have the same span of perception as a human gunner. The field of view that the gunner sees on his/her station's screen is not as wide as the typical human eye.[17] A traditional gunner may see something out of the corner of his/her eye that would not be seen by a CROWS gunner because it was out of the camera's range and not displayed on the screen. In summary, CROWS presents one major limitation, decreased situational awareness, which is a result of decreased stimuli and a limited range of view.

A final analysis used in determining systemic issues was determining if CROWS has any significant problems in functionality. Prior to March 2007, research indicated that CROWS had no major problems in functionality. According to the author's experience working with PM personnel from 2004 to 2005, most problems were corrected during the testing process prior to fielding. However, end-users identified two minor concerns in functionality. The first concern dealt with the difficulty with ammunition links getting stuck in the ammunition feed tray. The second was the lack of adequate internal battery

power.[18] CROWS can only operate for a limited time without starting the vehicle's engine. This functional limitation is not conducive to preventative maintenance and checks (PMCS) or training/practicing on the system between missions. These concerns, however, do not pose significant problems in CROWS functionality.

The story changed after March 2007. TACOM's SOUM announced that CROWS had a significant problem in functionality. The SOUM announced that a shortfall in software could cause CROWS to fire after power is cut to the control drives. This is a significant problem because it could result in fratricide. The SOUM directed that certain measures be taken until software can be implemented to correct the problem. As a result, the positive contributions CROWS makes to the battlefield are limited, if not all but temporarily terminated.

In summary, CROWS had only minimal systematic problems compared to a traditional M2 prior to March 2007. ORRs for CROWS were typically above 95% and faults were closely monitored and addressed by in-theater civilian maintenance support teams. Systematic issues identified prior to March 2007 included issues with hardware, none of which hindered the overall performance of the system. The most significant of issue associated with CROWS was decreased gunner situation awareness. After March 2007, CROWS was categorized as having significant problems in functionality as described in TACOM's SOUM, dated 8 March 2007.

This analysis would be incomplete if it did not account for what end-users had to say about the system. A major part of end-users' thoughts stem from the realism and usefulness of the CROWS training program. Soldiers' feedback overwhelmingly indicated that the initial training they received for CROWS was both realistic and useful.

Units receiving CROWS are identified by Multi-National Corps-Iraq (MNC-I), the organization having overall C2 over warfighting Army units in Iraq. MNC-I then publishes a directive outlining training allocations by unit, along with coordinating instructions and points of contact for the training.

All CROWS initial training in Iraq is conducted by the CROWS training and fielding element located in Balad and under the C2 of 1st Battalion, 402nd Field Support Brigade. Instructors are primarily government civil service employees, but a limited number of active duty Soldiers and military contractors also play a part. Initial training, known as new equipment training (NET), is conducted in a forty-hour block of instruction for users and an eighty-hour block of instruction for maintainers. For users, NET includes signing for CROWS, since end-users will bring the system back into the unit's property inventory after completing training.

Those individuals attending training, usually no more than ten per company-sized unit, are expected to train others in their unit on how to operate and/or maintain CROWS. This type of training is known as train-the-trainer (T3). NET includes classroom instruction and hands-on training using several CROWS simulators, designed to model the use of CROWS in a combat environment. A CROWS simulator is operated from a mock gunner's station which is nearly identical to a gunner's station found in a vehicle. Figure 5 depicts an actual CROWS simulator used during NET in Iraq. Training culminates in an actual tactical road march from Balad, Iraq to Range Hawaii, Iraq, followed by the successful completion of either a day or night weapons qualification. CROWS instructors are present at the range in order to validate training and weapons qualification.

Figure 5. Trainees on a CROWS Simulator, Balad, Iraq
Photo courtesy of 1st Battalion, 402nd Field Support Brigade.

The aspect of CROWS NET that end-users thought most beneficial was the extensive system overview the training provided. During training, end-users were not only instructed on how to operate, move, and shoot the system; they were also instructed on procedures and actions for a weapons malfunction. End-users also indicated that the civilian instructors provided a high level of system expertise, and that they enjoyed the extensive hands-on applications incorporated into the training.[19]

Although feedback unanimously indicated that training was realistic and beneficial, several end-users provided suggestions on how to make the training even better. Suggestions included having more simulators at the training site and incorporating simulators into the owning units in order to better train unit personnel not attending formal NET in Balad. Other end-users indicated that they already knew most of the

material presented during training because they had extensive knowledge with the M2 and MK-19 weapons mounted on CROWS.[20]

PM trainers working at the training and fielding site identified several positive and negative aspects of the NET program. Negative comments included the inability to train incoming units who will fall-in on CROWS, since NET is for initial fielding and training only. Other comments identified shortfalls in the ability to validate CROWS T3 at the unit level. Once a Soldier leaves training, does T3 in that unit occur, and if so, how thorough and realistic is it? Who validates the training? Another comment identified the need to conduct both night and day ranges for CROWS before training culminates. At the time of this study, training included either a day or night range, depending on scheduling and threat conditions. On a positive note, PM trainers indicated that because of their forward-based location and priorities, they receive the resources they need to maximize the benefits of training. They also have a group of trainers, most of whom are retired military personnel themselves, with a wealth of knowledge, experience, and commitment to saving service members' lives.

So what would end-users change about CROWS? The top three changes end-users would make include the manual focus function, the gunner's station joystick, and the two-feed ammunition tray. Changing the manual focus function was the one aspect of CROWS that Soldiers would most like to change.[21] The gunner must manually focus the system each time CROWS moves on to a different target. The system focuses on the target after the focus button is pushed, which takes additional time, although minimal.

End-users overwhelmingly would prefer that CROWS have an auto-focus function which would completely mitigate having to continually manually focus on a target.

End-users would also change the gunner's station joystick. Although end-users indicated that the one-hand control mechanism was a luxury compared to a traditional weapon, the joystick caused cramping in the gunner's hand after prolonged use. End-users also indicated that the joystick could have a more modern design, although this was mainly for aesthetic reasons. The third aspect of CROWS that end-users would change is the two-feed ammunition tray. End-users indicated that they would prefer a one-feed tray because it would make loading ammunition easier.[22] It would also minimize the probability of an ammunition jam. In the event of an ammunition jam, the gunner must exit the vehicle through the turret to correct the jam, which negates the increased force protection CROWS provides.

Now that changes have been addressed, what aspects of CROWS would end-users maintain? The top three aspects of CROWS that end-users would maintain are CROWS' enhanced visual capabilities, increased accuracy, and increased force protection. Of the three, the aspect that end-users favored most was the enhanced visual capabilities CROWS provides.[23] Enhanced visual capabilities are defined as CROWS' zoom and night vision/thermal capability. Unlike a traditional weapon, CROWS can zoom-in on a target, much like a traditional handheld camera. As discussed previously in this chapter, CROWS' zoom and night vision/thermal capabilities provide the gunner with increased lethality and visual capability, to name a few.

Increased accuracy was also an aspect of CROWS end-users would maintain. End-users felt that CROWS was more accurate than a traditional M2.[24] The final aspect

of CROWS that end-users would maintain was the increased force protection it provided. Although end-users identified flaws in the system, they indicated that they would much rather be inside of an armored vehicle than exposed to external threats in the vehicle's turret.[25]

Outside of end-users, what do others, specifically leaders, think of CROWS, and what unique issues does CROWS pose for them? Research indicated that CROWS posed both positive and negative issues for leaders. Positive feedback identified a leader's increased ability to more effectively communicate with a gunner using CROWS opposed to a gunner in the turret of a vehicle.[26] It is common practice to have at least one leader in the rank of sergeant or above in each vehicle operating in off-base convoys in Iraq. This leader is more able to communicate with the vehicle's gunner when he or she is inside of the vehicle and in close proximity. This is not the case when the gunner is in the turret and can not hear voices inside of the vehicle. It should be noted that some vehicles have intercom systems that link all personnel in the vehicle, but these systems are not present in all vehicles.

Additional feedback identified how CROWS increases leaders' responsibilities. CROWS operates much like a modern-day video game. Leaders must ensure that CROWS' advanced technology and "video game" concept does not desensitize gunners to the fact that they are operating a lethal crew served weapon capable of devastating effects. Leaders must mitigate this issue by reinforcing respective rules of engagement and ensuring that subordinates clearly understand their context.

CROWS also places additional requirements on leaders in terms of training, accountability, and maintenance. Like other materiel, CROWS must be maintained,

which includes scheduled services and repair, as required. CROWS must also be accounted for according to DA guidelines, a potentially tedious task given its many components. Finally, leaders must ensure that Soldiers are trained on CROWS. They must ensure that training takes place, is realistic and challenging, and is evaluated in order to ensure standards are met. Training includes initial T3 training and refresher training. These issues are significant since CROWS is only fielded to units in Iraq, an environment where leaders at all levels are challenged with many issues in a dynamic and hostile environment.

In summary end-users had overall positive feedback on CROWS. They overwhelmingly thought that the training they received for CROWS was both adequate and realistic, particularly with respect to NET. The top three aspects of CROWS that end-users would change were primarily aesthetic in nature. The top three aspects of CROWS that end-users would keep were much more critical to combat operations: increased visual capabilities, increased accuracy, and increased force protection. Finally, CROWS does put additional requirements on leaders, but those requirements do not deviate far from those basic leadership practices for which leaders are normally responsible.

CROWS is a highly technical, state-of-the-art system. What additional resources, if any, are required to support it? Most technically advanced systems come with a high price tag. What is the monetary cost of CROWS? The cost of one CROWS is approximately $200,000.[27] This cost reflects the CROWS model fielded at the time this thesis was written and does not include the cost of the weapon. This cost reflects materiel only and does not include associated research and development costs or fielding and maintenance costs.

Along with high costs, advanced systems can require increased and specialized personnel support. What are the personnel requirements for CROWS? CROWS does not require additional personnel at the unit level, but does require additional personnel for initial fielding, training, and sustainment. These additional personnel man the CROWS training and fielding site in Balad, Iraq. According to the 402nd Field Support Brigade Personnel Officer, the organization ranges from 12-16 personnel. At the time this thesis was written, the organization had fourteen personnel, eight DA civilians and six civilian contractors. There were no military personnel, although the organization usually does have 1-2 active duty military personnel assigned.[28] The contractors were employed by Recon/Optical Incorporated, the civilian company that manufactures CROWS for the military. The site manager was a DA civilian holding the rank of GS-13.

CROWS is currently only fielded to units already in Iraq supporting OIF. What unique resources are required for forward-based operations? In terms of fielding, CROWS requires additional personnel and facilities to store and field the system to units. Fielding also requires transportation assets to bring the system to Iraq, which also comes at a high cost to the US government. CROWS fielding consumes critical, finite, in-theater airlift assets since the systems are flown directly into Balad, the central fielding location within Iraq.

In terms of training, CROWS requires additional personnel to conduct the forty-hour initial NET block, as well as limited training for replacement units falling-in on the system in theater. Similar to fielding, training requires facilities and space. Training also requires close coordination with external elements in Iraq. Coordination must be made with MNC-I for training, as well as with the receiving units. Finally, training requires an

inherent risk to force protection since all initial training culminates with a tactical convoy to Range Hawaii for qualification.

In terms of operation, CROWS requires a power supply. This is not the case with a traditional weapon. CROWS is powered by an internal battery pack, or by the vehicle's engine. In terms of maintenance, CROWS requires support from the personnel at the CROWS fielding and training site in Balad. Most faults can not be corrected at the unit level; they require support from mobile, civilian maintenance teams from Balad. These teams require transportation to the repair site and life support once they arrive. With respect to repair parts, CROWS requires the training and fielding site to stock CROWS-specific parts in the event a replacement part is required. In summary, CROWS requires many unique resources in order to support forward-based fielding, training, operation, and maintenance. Although these additional resources do not pose a problem, they are not required for a traditional M2.

Analysis of the unique requirements and resources of CROWS indicated a need for several additional resources. Each CROWS costs approximately $200,000, so there are additional economic resources required. CROWS also requires additional civilian personnel, (and associated transportation and life support), to implement NET, system fielding, and maintenance. Finally, CROWS requires additional hardware to power the system, as well as specialized training and training resources to qualify end-users.

Perhaps the most significant analysis in determining whether CROWS is an improvement over a traditional weapon system was analyzing its limitations across DOTMLPF domains. First, what are CROWS' limitations with respect to doctrine? In

order to answer this question, one must first determine what doctrine currently exists for CROWS and what doctrine is in the works.

There is currently no formally-published DA-level doctrine for CROWS. Students attending NET receive Technical Manual (TM) 9-1090-218-10, Operator's Manual For The Armament Subsystem: Remotely Operated, XM101; Common Remotely Operated Weapon Station (CROWS), a -10 user's manual published by the PM, as well as informal student handouts and quick reference guides for critical tasks, to include bore sight operation and zeroing procedures.[29] According to personnel at the USAMPS, MP doctrine may be modified to reflect CROWS. USAMPS is currently studying tactics, techniques, and procedures (TTPs) used in Iraq as the basis for a potential change to doctrine.[30] Maintainer's NET trainees receive Technical Manual TM 9-1090-218-23&P, CROWS Maintenance Manual, which at the time this thesis was written was still in draft form. Both TM 9-1090-218-10 and 9-1090-218-23&P are not available through the Army's publication system like other TMs. They must be obtained through formal PM channels.

The primary limitation with respect to doctrine is that no DA-approved publications are readily available for CROWS operation or maintenance. Although CROWS can be simply considered as a system that allows a traditional M2 to fire remotely, it still has unique capabilities and requirements that should be incorporated into some form of formal doctrine. Existing M2 doctrine, primarily FM 3-22.65, *Browning Machine Gun, Caliber .50 HB, M2* is not enough. This publication does not address many of the issues associated with CROWS as discussed earlier in this chapter, to include

differences in materiel, capabilities, and human aspects such as desensitization and decreased situational awareness.

The *Soldier's Manual of Common Tasks-Skill Levels 1* and *2-4* provides training procedures and standards for those tasks associated with the operation, use, and maintenance of the M2, to include convoy operations. But like FM 3-22.65, this publication does not address how remotely operated systems change and/or affect procedures for M2 use, whether in a convoy or not. The same is true for convoy-specific doctrine like FM 4-01.011, *Unit Movement Operations,* FM 55-30, *Army Motor Transport Units and Operations,* and FM 19-25, *Military Police Traffic Operations.* These resources do not provide detailed information on convoy operations and security beyond traditional weapons.

CROWS requires additional doctrine beyond what is already published. Unfortunately, the process will likely be a slow one, if we see it at all. FM 3-04.15, *Multi-Service Tactics, Techniques and Procedures for the Tactical Employment of Unmanned Aircraft Systems,* was published in August 2006. To date, this is the only FM that addresses the implementation of unmanned weapon systems at the tactical level. There is no doctrine published for unmanned ground systems/robotics. The primary reason may be the rapid speed at which these systems are being fielded to units, in particular to units in Iraq. The demand for these systems is so great that steps to incorporate them into doctrine are being skipped or deferred until a later date. Unfortunately, this shortchanges the end-users to a certain degree. Another reason for the lack of published doctrine is that the effects and best procedures for this type of weapons/systems are still being collected and analyzed in the form of TTPs, as representatives of the USAMPS indicated.

Next, what are CROWS' limitations with respect to organization? At this time, there are no significant limitations with respect to organization. CROWS is primarily fielded to MP units. Transportation, Infantry, Engineer, and US Air Force units have also received CROWS, but in limited numbers.[31] For the purposes of this thesis, MP units were the type of unit analyzed. Although modified tables of organization (MTOE) vary, most Army MP company-sized units are authorized the M2 machine gun.[32] CROWS does not require any changes to a unit's MTOE structure, despite how many M2s a company is authorized.

Company-sized elements and below may informally reorganize based on the leader's guidance and discretion. For example, vehicles with CROWS have less occupancy space because gunners are now inside of the vehicle and not in the turret. The seat that was once filled by an occupant is now filled by the gunner, reducing occupancy from five to four personnel. This may cause reorganization with respect to the number of vehicles in a convoy and where and how vehicle loads are configured. CROWS can also influence the configuration of a convoy. Based on the threat level and leader guidance, vehicles with CROWS may be placed in certain locations within convoys or serials to maximize lethality and force protection.

CROWS is currently maintained by the maker, Recon Optical, Incorporated, under a Contractor Logistic Support (CLS) agreement. Changes or modifications may be necessary in terms of supporting units when and if this agreement comes to an end. Units owning the Soldiers that are to perform maintenance and services on CROWS may require a change or modification to their respective MTOE in terms personnel and/or equipment.

What are CROWS' limitations with respect to training? Many of the CROWS training limitations expressed by Soldiers were addressed earlier in this chapter. Unfortunately, they are not the only limitations. One of the most significant limitations is the lack of published standards to evaluate training. CROWS is not incorporated into any of the *Soldier's Manual of Common Tasks*. It is also not covered in any published mission training plan (MTP) or Army Training and Evaluation Plan (ARTEP). MTPs and ARTEPs lay out the approved task, conditions, and standards for those military tasks Soldiers and Army elements are responsible for meeting in order to support their respective wartime mission essential task list (METL).

Currently, the only type of training evaluation being conducted is by CROWS training and fielding personnel in Balad. Unfortunately, the evaluations are informal and not approved or published by DA. It is simply not possible to validate CROWS training without published standards. This is not the case with the M2 machine gun. The Soldier's Manual of Common Tasks-Skill Levels 1 and 2-4 thoroughly incorporate M2 operation and training standards. M2 operations are also fully incorporated into combat arms, combat support, and combat service support MTPs and ARTEPs.

There is also a limitation with training those units which fall-in on CROWS in Iraq. CROWS does not leave theater and becomes property of a unit only during their rotation in Iraq. When these units arrive, they conduct a relief-in-place (RIP) with the outgoing unit. A RIP can last anywhere from one week to one month depending on the personnel force flow into theater. The outgoing unit is responsible for training the new unit on CROWS sometime during the RIP. Unfortunately, there are a myriad of tasks that occur during a RIP and CROWS training is likely not the most important. As a result,

incoming units often have to learn through hands-on experience, which is not a preferred method, particularly in a fast-paced combat environment.

If feasible, new units are able to contact the CROWS training and fielding site in Balad, (in accordance with MNC-I), to schedule training.[33] Unfortunately, not all Soldiers attend and those who do are responsible for quality T3, a difficult task in an already demanding combat environment. Those who do attend are also limited, as they do not participate in the same training provided during NET, most importantly the culminating weapons qualification or tactical convoy to Range Hawaii. According to personnel at the CROWS training and fielding site in Balad, commanders are already stretched thin with respect to time and personnel, so the time allotted to T3 back at the unit is often not what it should be.[34]

Another limitation is the fact that training currently occurs in Iraq only. Personnel at the USAMPS expect CROWS to eventually be included in institutional training. The USMPS is the Army's Training and Doctrine Command (TRADOC) proponent for CROWS.[35] Training would be incorporated into MP Advanced Individual Training (AIT), the Basic Noncommissioned Officer Course (BNCOC), and the Advanced Noncommissioned Officer Course (ANCOC). The primary reason for its current absence stems from budgeting.[36] The USAMPS has conducted very limited training to AIT students and students attending the MP Captain's Career Course (CCC), but this is mainly for basic familiarization and is informative in nature, rather than hands-on.[37]

In addition, CROWS is not currently incorporated into the Army's Combined Training Centers (CTC) at Fort Polk and Fort Irwin. This is obviously not the case with the M2 machine gun, which remains a critical piece of equipment used during CTC

rotations. According to the America's Army website, the Army does plan to develop a basic skills trainer (BST) for CROWS.[38] The BST would be used in CONUS, much like BSTs are currently used for other weapons systems, to include the M2. Although this is certainly a step in the right direction with respect to raining, it is still on the horizon, as are most improvements and additions to CROWS training.

A final limitation is a potential one. There may be additional training requirements when and if CROWS is no longer contractor-supported for maintenance. Soldiers will then be responsible for performing higher-level maintenance on the system, for which they will have had no formal training. Potential outcomes include a change in the training program at TRADOC schools and AIT programs, or an internal, DA-approved training program at the unit-level.

What are CROWS' limitations with respect to materiel? CROWS has no significant limitations with respect to materiel. Minor limitations do exist with materiel used for maintaining CROWS. As discussed earlier in this chapter, CROWS is powered in one of two ways—through an internal battery with limited power, or through a running vehicle's engine. CROWS is equipment dependent for power. The M2 machine gun is not; it can operate without a power source.

Most tools required to correct minor maintenance problems can be supported by internal tools located at the owning unit. More significant and technical maintenance problems are fixed by CROWS personnel out of Balad using specialized tools and equipment. There is also a minor limitation along those same lines with respect to CROWS repair parts. CROWS repair parts are not currently available through the Army's supply system. All repair parts are maintained in Balad at the CROWS training

and fielding site. Repair parts for the M2, on the other hand, are all available through Army supply channels.

With respect to additional materiel required for CROWS, a boresight kit is issued to crews during NET. This is only a limitation if the unit misplaces the kit or any of its components because, like repair parts, it is not available through Army supply channels. Overall, only minor limitations exist for CROWS in terms of materiel. Although they are minor, these limitations do not exist for a traditional M2 machine gun.

Similar to training, materiel requirements for CROWS may change if and when the system is no longer contractor-supported for higher level maintenance. If maintenance units are responsible for performing all levels of maintenance and services, they will need the specialized tools that ROI and PM personnel currently possess. This will result in additional materiel required at the unit level.

What are CROWS' limitations with respect to leadership and education? With respect to leadership, the most significant limitation is that leaders have little to no experience, training, or familiarization with CROWS until they arrive in Iraq. In blunt terms, the system is thrown at them in a combat environment with no published standards for training and maintaining. CROWS just becomes another piece of equipment for which leaders are responsible. They also have limited skills and knowledge, especially early on in their deployment, on how to best employ the system. CROWS brings increased capabilities to a combat environment, but they are useless if leaders do not implement the system in a way that maximizes these capabilities. CROWS is only as beneficial as leaders allow it to be.

In terms of education, CROWS falls short in comparison to an M2. Most Army personnel are unfamiliar with CROWS unless they have had first-hand experience, by either using or seeing the system in Iraq. Personnel in the acquisition community or those serving in high-level positions may have limited exposure and knowledge of the system, but this includes a very small population of the total Army force. Much like CROWS training, the Army still has a long road ahead in terms of incorporating CROWS into its education system. The Army seems to want to integrate CROWS into its education system, as noted by USAMPS personnel, but to date it has yet to come to fruition. Unfortunately, this is a major shortfall of CROWS. Personnel are not educated on the system prior to exposure in a combat environment. Education with respect to the M2 machine gun is entirely different. The M2 has existed in the Army's equipment inventory long enough that you would be hard pressed to find a Soldier, regardless of rank, that has not received some sort of M2 exposure and familiarization during their career.

CROWS and personnel requirements were briefly discussed earlier in this chapter. But what are CROWS' limitations with respect to personnel? As mentioned earlier, CROWS requires a personnel support package to field the system, train individuals initially receiving the system, and maintain the system once it is fielded. At the time this thesis was written, 257 CROWS were fielded to units in Iraq, completing 100% of the initial operational needs statement (ONS).[39] The personnel support package that made this possible was consistently under fifteen personnel, which is relatively small given their large training, fielding, and sustainment mission.

But this forward-deployed personnel team is not working in a vacuum. There are countless support personnel, primarily in the acquisition community, located at Picatinny

Arsenal, New Jersey and the Army Sustainment Command, Rock Island Arsenal, Illinois, whose job it is to keep the CROWS program up and running, from budgeting to implementation. These requirements are not expected to decline. The newly approved ONS for CROWS began fielding 779 additional systems in March 2007.[40] If anything, the personnel support requirements will only increase. What this means is that you currently can not implement any portion of the CROWS program without a large personnel support package, part of which must be forward deployed in the respective theater of operations.

CROWS has less of an effect on personnel in military units. Unlike many other weapon systems, CROWS does not require an additional skill identifier (ASI) for users or maintainers. An ASI is used to identify specialized personnel skills requiring specific, formal training or certification. In addition, CROWS does not require additional military occupational specialties be created for users or maintainers. As a result, there are currently no additional personnel requirements for CROWS at the user level.

There is a distinct difference with respect to personnel when comparing CROWS and the M2 machine gun. Barring extreme circumstances and higher levels of repair, the M2 machine gun can be sustained with internal military personnel. The M2 does not require a personnel support package for operation, training, fielding, and sustainment. For this reason, the M2 has far less limitations than CROWS with respect to personnel.

Finally, what are CROWS' limitations with respect to facilities? CROWS does not require additional facilities at the owning unit. Although facilities vary by location and type of unit, the standard facilities available in the average motor pool are adequate

to support CROWS.[41] CROWS limitation in terms of facilities comes when the training, fielding, and sustainment requirements are factored in.

CROWS training requires an entire facility for its purposes. The facility must be able to house two simultaneous NET classes, one for users and one for maintainers. The facility must also be large enough to hold multiple vehicles on which CROWS is mounted for training. Fielding and sustainment also have a facility requirement. Storing pre-packaged, boxed systems for fielding requires indoor storage and a large amount of space. Similarly, repair parts also require indoor storage space. Parking space is also a factor. The vehicles that CROWS are mounted on require parking space during training and initial fielding.

Groundbreaking for a new, larger facility in Iraq was conducted in March of 2005 in Balad. The new facility nearly doubled in size compared to the old facility and was completed in June 2005. The CROWS operation in Iraq simply outgrew their old facility due to the increase in the number of trainees and systems fielded. Requirements will only increase further as more systems are fielded. The M2 machine gun does not require the additional facilities that CROWS does. A traditional M2 requires no additional facilities for training, fielding, and sustainment in a forward-deployed location.

Table 2, the DOTMLPF analysis matrix, provides a snapshot of the limitations of CROWS analysis across DOTMLPF domains.

This chapter answered all secondary and tertiary questions. Chapter 5, "Recommendations and Conclusions," discusses the results and draws conclusions from this analysis. Chapter 5 also provides recommendations for future CROWS implementation and identifies topics for further research.

Table 2. DOTMLPF Analysis Matrix

Domain	Significant Limitation (CROWS)
Doctrine	Only a -10 manual exists
	DA-approved doctrine for maintenance and sustainment in draft form
	Only informal TTPs available for operation and tactics
	No fixed date on when formal doctrine may be published
	CROWS not addressed in existing doctrine
Organization	Internal vehicle organizes reduced troop occupancy
	May informally reorganize UBL and load plans
Training	Lack of published standards on training evaluation
	Unsupervised training during relief-in-place (incoming units)
	Limited number of seats for NET and relief-in-place personnel
	Training currently limited to Iraq
	Lack of funding for CONUS-based training at TRADOC installations
	Basic skills trainer not yet available
	Not incorporated into CTCs
Materiel	Ability to provide extended internal power
	Boresight kit only available through project manager channels
	Class IX repair parts not incorporated into the Army supply system
Leadership & Education	Leaders have little to no prior experience or familiarality
	Responsibility to account for and sustain
	Increased enforcement of rules of engagement
	Very limited education outside of the theater of operations
Personnel	Forward-based personnel support package
	CONUS-based personnel support package
Facilities	Additional forward-based training and fielding facilities required
	Robust storage requirement

[1]US Army Development Test Command, Test Record for the Common Remotely Operated Weapons Station, RDECOM, Aberdeen Proving Ground, MD, September 2002; [Study results online] available from www.dtic.mil/ndia/2005armaments/ sebasto.pdf ; Internet; accessed 18 October 2006.

[2]Brian Webster, Balad, Iraq, electronic mail correspondence to author, Ft. Leavenworth, KS, 16 November 2006.

[3]PEO Soldier, Common Remotely Operated Weapon Station (CROWS); accessed 21 December, 2005; [Document online]; available from http://.peosoldier.army.mil/factsheets/SW_CSW_CROWS.pdf; [Document online]; Internet.

[4]Ibid.

[5]Ibid.

[6]Ibid.

[7] SGT Daniel W. Bailey "*CROWS Keeps Gunners Out of Harm's Way*," Defend America News Article: 20 June 2005, accessed 29 September 2006; available from http://www..defendamerica.mil/articles/june 2005/a062005la4.html; [Article online]; Internet.

[8] Ibid.

[9] Military Police Battalion, 101st Airborne Division, Fort Campbell, Kentucky, telephonic focus group, 13 December 2006.

[10] Ibid.

[11] Collateral Damage. Dictionary.com. *The American Heritage® Dictionary of the English Language, Fourth Edition*. Houghton Mifflin Company, 2004; accessed 31 January 2007; available from http://dictionary.reference.com/browse/collateral damage; (Dictionary online]; Internet..

[12] Brian Webster, Balad, Iraq, email correspondence to author, Ft Leavenworth, KS, Iraq, 9 January 2007.

[13] US Army Tand-automotive and Armaments Command. "Safety of Use Message 07-001," Warren, MI: TACOM, 8 March 2007.

[14] Military Police Battalion, 101st Airborne Division, Fort Campbell, Kentucky, telephonic focus group, 13 December 2006.

[15] 1st Battalion, 402nd Field Support Brigade, Briefing slides, Balad, Iraq, May 2006.

[16] Brian Webster, Balad, Iraq, email correspondence to author, Ft Leavenworth, KS, 9 January 2007.

[17] Ibid.

[18] CROWS Training and Fielding Office, After-action reviews, Balad, Iraq, 13 December 2006.

[19] Ibid.

[20] Ibid.

[21] Ibid.

[22] Ibid.

[23] Ibid.

[24] Military Police Battalion, 101st Airborne Division, Fort Campbell, Kentucky, telephonic focus group, 13 December 2006.

[25] Ibid.

[26] Paula Taylor "Tank Unit Fields Remote Weapon System," Fort Bliss, TX: Army News Release, 2006, accessed 29 September 2006; [Article online]; available from http://www.roi.bourns.com/News/Default.asp; Internet.

[27] Pike, *XM101 Common Remotely Operated Weapon Station (CROWS)* (Global Security.Org, 2005, accessed 8 September 2006); [Online document]; available from http://www.globalsecurity.org/military/systems/ground/m101-crows.htm; Internet.

[28] Maria Cris Foster, Balad, Iraq, email correspondence to author, Ft Leavenworth, KS, 22 January 2007.

[29] Brian Webster, Balad, Iraq, email correspondence to author, Ft Leavenworth, KS, 25 October 2006.

[30] CPT Matthew K. McKinney, Ft Leonard Wood, MO, email correspondence to author, Ft Leavenworth, KS, 18 December 2006.

[31] Brian Webster, Balad, Iraq, email correspondence to author, Ft Leavenworth, KS, 16 November 2006.

[32] FMS website, accessed 23 February 2006; [Online MTOEs]; available from https://webtaads2.belvoir.army.mil/WebTAADS/tools.asp; Internet.

[33] Wayne Cook, Balad, Iraq, email correspondence to author, Ft Leavenworth, KS, 30 October 2006.

[34] Ibid.

[35] Chester Topolski. Presentation: Small Arms Systems Symposium, National Defense Industrial Association. 15 May 2002.

[36] CPT Matthew K. McKinney, Ft Leonard Wood, MO, email correspondence to author, Ft Leavenworth, KS, 18 December 2006.

[37] Ibid.

[38] America's Army. "Common Remotely Operated Weapon Station" [online document]. America's Army, accessed 14 February 2007, available from http://info.americasarmy.com/projects.php?id=10; Internet.

[39] Vera Lenin, Balad, Iraq, email correspondence to author with slide attachment, Ft Leavenworth, KS, 12 January 2007.

[40] Ibid.

[41] Wayne Cook, Balad, Iraq, email correspondence to author, Ft Leavenworth, KS, 30 October 2006.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

This chapter will provide conclusions and recommendations based on the analysis discussed in chapter four in order to answer the primary research question, is CROWS an improvement over a traditionally manned weapon system? This chapter first discusses the conclusions of the study, what they mean, what the implications are, and whether there were any unexpected findings. Next, recommendations are discussed, to include suggestions for future study, any unanswered questions, things that could have been approached differently, and whether there are any subsequent actions to be taken. The analysis performed for this thesis indicated that CROWS has several benefits over a traditional M2, to include increased force protection and increased hardware capabilities. Overall, these benefits do not make CROWS an improvement over a traditionally manned weapon in combat.

Analysis proved that there is currently no compelling information that proves that CROWS has significant benefits over a traditional weapon system. Evidence does not show that CROWS increases lethality or decreases collateral damage. CROWS may improve force protection for those inside of a vehicle, but the problems the system currently faces in terms of functionality increases the chances for fratricide to those not inside of an armored vehicle or other form of cover.

Although end-users like the system, the major aspects they mentioned do not necessarily make CROWS better than a traditional M2. Users liked the system's advanced technology and protection of operating the weapon from inside of an armored

vehicle, but they did indicate that it was necessarily an improvement over a traditional M2. CROWS also requires additional resources that a traditional M2 does not. The most significant was the cost. At slightly over $200,000 per system, not including the weapon, CROWS bears a high price tag, particularly when it does not necessarily provide significant benefits and currently has notable problems in functionality. The benefits just do not outweigh the cost.

CROWS also fell short with respect to DOTMLPF. The lack of published doctrine was a significant shortfall. The limitations with respect to training, both inside and outside of Iraq, was also a significant limitation. Although doctrine and better training are presumably on the horizon, they can not be considered in CROWS' favor because they simply do not exist in the current operating environment. Another shortfall with respect to doctrine centers around CROWS' limited use in the Iraq. Current TTPs only capture CROWS performance in that particular environment, which may not be applicable or appropriate for doctrine incorporating CROWS or other robotics on the battlefield. CROWS also brings with it a robust personnel and facility support package, which you do not have with a traditional M2. The personnel and facilities required to support an M2 are inherent to organic military units and do not require additional support.

The implications of these conclusions are significant. The military is putting a very expensive system in the hands of Soldiers with little to no experience with the system, little to no doctrine to serve as reference, little to no training, and little to no qualitative information that proves its benefits. These implications do not even consider the fact that the system currently has significant problems with functionality that has

caused its use to be all but terminated in Iraq. Implications on a larger scale may affect other unmanned, robotic weapon systems. If the Army is having these problems with CROWS, what other systems that are costing a lot of money will have a similar performance? The military may need to relook how it is implementing advanced technology and to what degree we are dehumanizing weaponry.

Senior leaders believe they are helping Soldiers by fielding systems like CROWS. However, when the development and indoctrination process of such systems is so rushed that we develop training on the fly and issue a deadly weapon system without doctrine, there may be negative results. Weapon systems like CROWS are best suited for the traditional fielding and development process that the Army's acquisition community developed. Although this process is time consuming, it is thorough and more fully tests a product before putting it in the hands of Soldiers. This is obviously a trade-off given the time constraints combat often poses, but systems that have lethal effects, like CROWS, need acute study and analysis before fielding. In addition, how far is the military willing to go to dehumanize fighting? There is something to be said for having a living, breathing human fully exposed to all external stimuli behind a crew-served weapon that can potentially cause mass destruction.

There were several unexpected findings during the research and analysis process. First, and most significant, was the information regarding the problems in functionality associated with CROWS. When research began, the author did not expect that a SOUM would have been published that, by the time the analysis was finalized, would all but terminate CROWS operation in Iraq until major software problems were corrected. The

author also did not expect to discover that this malfunction would be the cause of several incidents of fratricide in Iraq.

Second, end-users did not like CROWS as much as the author initially expected. This study only highlighted the top three positive and negative aspects noted by Soldiers, but there were certainly more than enough negatives noted to devote to additional analysis. Finally, there were larger than expected shortfalls associated with CROWS across DOTMLPF domains, particularly with respect to doctrine and training. These shortfalls were not the case when analyzing a traditional M2, which is fully incorporated into Army doctrine and training. In fairness, it should be noted that the M2 machine gun has been in the military's inventory for a significantly longer time than CROWS. This fact, however, did not cover up the significant shortfalls with respect to CROWS.

Recommendations

It is highly recommended that further study be conducted in the military's use of unmanned weapon systems and robotics. Unmanned systems and robotics are now a permanent part of the military's inventory, and their numbers are sure to grow. Unfortunately, there has not been much written about the applications of these systems, their benefits, and how they fit into the current operating environment. To date, analysis of these systems has been largely quantitative in nature. Qualitative analysis is desperately needed. In addition, much of what has been written and studies involved unmanned aerial systems. Unmanned ground systems have largely been untouched. The speed at which these systems are currently being fielded may be partially to blame. However, if the military plans to continue using unmanned systems, particularly ground

systems, then we owe it to our forces to explore, analyze, and document all that we can about how to best employ them.

The most significant unanswered question to this research is arguably unanswerable. Does CROWS actually save lives? This question leads to another recommendation for further study. The military should take a hard look at whether or not the resources put into systems like CROWS actually saves the lives of the Soldiers using them. This is a difficult task, but one the military needs to consider. If CROWS saved just one life, then it is arguable worth every cent and additional resource. However, to date there is no quantifiable or qualitative data or analysis that proves the case. To date, all we have proof of is that CROWS has significant software issues that have caused physical injury to friendly forces.

There are several things about this study that could have been approached differently. First, analysis could have focused more on the costs associated with CROWS. Specifically, what programs does CROWS funding take from, and what are the implications? This data would have been a powerful tool in determining whether CROWS is an improvement over a traditional weapon. Analysis on where the funding will come from to correct problems in functionality could have also been considered as this will likely increase costs significantly. Research and development costs for CROWS could have also been explored. Second, analysis could have involved a larger population. Data on issues regarding leadership were limited, and CROWS developers at the PM office had no input. Finally, research was limited to the M2 machine gun and neglected results and CROWS performance with respect to other weapons systems, to include the MK-19 grenade launcher and the M249 SAW. It is possible that results from these

weapon systems would have been different, thereby changing or altering some conclusions.

There are several actions that should be taken as a result of this analysis. First and foremost, the military should immediately begin incorporating CROWS into its doctrine and training programs. At the time this thesis was published, CROWS had been in Iraq for just under two years with only a -10 manual for users. Doctrine for sustainment was still in draft form. The same is true with respect to training. Funding was causing a delay in incorporating CROWS into training at the USMPS. In addition, training was still limited to Iraq only. The military must expect problems to arise if it is going to field this system directly to a combat environment with no prior training, whether at home station or at the CTCs.

This study has shown that at this time, CROWS is not an improvement over a traditionally manned weapon in combat. CROWS possesses advanced technology that increase capabilities, but these capabilities do not necessarily make it an improvement over a traditional weapon system. Additionally, we must consider the significant problems CROWS software is currently causing. The primary reason CROWS was developed in the first place was to save lives, not cause fratricide. One incident of fratricide is too many. In closing, the military must do all it can to provide those fighting on the front lines with the best equipment possible. At this time, CROWS just is not the best we can do.

GLOSSARY

After Action Review (AAR): AARs are the military's primary tool for capturing data and information from an operation or plan after it has been conducted. AARs usually address what happened, what was supposed to happen, as well as positive and negative aspects of the operation. Input is derived from those who participated.

1st Battalion, 402nd Field Support Brigade: A subordinate command of AMC. This battalion is forward-deployed in support of OIF and is headquartered in Balad, Iraq. This battalion has overall C2 responsibility for the fielding and training of all OIF forces receiving the CROWS. The CROWS fielding and training element is a subordinate component of the battalion, much like a company is to a battalion. The CROWS element is the link between the

PM and the end-user. This battalion employs CROWS trainers and specialized maintainers from ROI who are capable of providing on-site, specialized maintenance support to the CROWS in theater, usually when the fault exceeds parent unit capabilities.

Army Materiel Command (AMC): An Army major command (MACOM), much like Central Command (CENTCOM) and European Command (EUCOM). AMC has overall acquisition and logistics responsibility for the US Army.

Crew Served Weapons: Crew served weapons are weapons operated by more than one person, but not necessarily at the same time. They fire larger-caliber ammunition and therefore have a large capacity for damage.

Operation Readiness Rate (ORR): Unit-generated reports that capture the percentage of fully-mission capable equipment at a moment in time; may be used for one certain type of equipment or multiple; may be used for any size element.

Program Manager (PM): Subordinate elements of the DA's Acquisition, Logistics, and Technology branch. CROWS falls under the Program Manager (PM) Crew Served Weapons branch.

Recon/Optical Incorporated (ROI): The civilian company that produces the CROWS for the Army, headquartered in Barrington, Illinois.

Support Operations (SPO): A sub-element of an Army logistics battalion headquarters responsible for the execution, command and control, and quality assurance of provided logistics.

Up-Armored: Up-armored is an adjective used for military TWVs that indicates the vehicle has armor plating and other additional protection. The CROWS is only mounted on up-armored vehicles.

BIBLIOGRAPHY

Books

Ayers, Robert U., and Steven M. Miller. *Robotics: Applications and Social Implications*. Cambridge: Ballinger Publishing Company, 1983.

Killblane, Richard E. *Circle the Wagons: The History of US Army Convoy Operations*. Fort Leavenworth: Combat Studies Institute Press, 2005.

Macksey, Kenneth. *Technology in War: The Impact of Science on Weapon Development and Modern Battle*. New York: Prentice Hall Press, 1986.

Mahan, D.H. *An Elementary Treatise on Advanced-Guard, Out-Post, and Detachment Service of Troops, and the Manner of Posting and Handling Them in Presence of an Enemy*. New York: John Wiley, 1861.

Turabian, Kate L. *A Manual for Writers of Term Papers, Theses, and Dissertations*. Chicago, IL: The University of Chicago Press, 1996.

US Department of the Army. FM 3-22.65, *Browning Machine Gun, Caliber .50HB, M2*. Washington, DC: Government Printing Office, 2005.

_____. FM 4-01.011, *Unit Movement Operations*. Washington, DC: Government Printing Office, 2002.

_____. FM 6-22, *Army Leadership*. Washington, DC: Government Printing Office, 2006.

_____. FM 7-0, Training the Force. Washington, DC: Government Printing Office, 2004.

_____. FM 55-30, *Army Motor Transport Units and Operations*. Washington, D.C.: Government Printing Office, 1997.

_____. FM 19-25, *Military Police Operations*. Washington, D.C.: Government Printing Office, 1977.

_____. U.S. Army Soldier's Manual of Common Tasks STP 21-1-SMCT, *Soldier's Manual of Common Tasks, Warrior Skills, Level* 1. Washington, D.C.: Government Printing Office, 2006.

_____. U.S. Army Soldier's Manual of Common Tasks STP 21-24-SMCT, Soldi*er's Manual of Common Tasks, Warrior Leader, Levels 2, 3, and 4*. Washington, D.C.: Government Printing Office, 2006.

Articles

BBC News. “US Plans ‘Robot Troops’ for Iraq, United Kingdom” BBC News Service, Article on-line. Available from http://news.bbc. co.uk/1/hi/world/Americas/ 4199935.stm. Internet. Accessed 12 December 2006.

Bailey, Daniel W. “CROWS Keeps Gunners Out of Harm’s Way” Army News Service. Online article. Accessed 29 September 2006. Available from http://peosoldier.army.mil/pmweapons/crows.asp. Internet.

Barrett, Kristina, SSG. “CROWS Gets Airmen Out of the Turret.” Air Force link. Available from http://www.af.mil/news/story.asp?storyid=123019644. Internet. Accessed 29 September 2006.

Cast, Mike. “Soldier Tester at Aberdeen Test Center Helps Army Develop Common Remotely Operated Weapon Station.” *Defense Acquisition and Technology*, November-December 2005, 3.

Program Executive Office Soldier, “Common Remotely Operated Weapon Station-Lightning.” Online article. Accessed 21 December 2006 and 11 January 2007, available at: http://www.peosoldier.army.mil. Internet.

Taylor, Paula. “Tank Unit Fields Remote Weapon System. Fort Bliss, TX: Army News Release, 2006. Online article. Available from http://www.roi.bourns.com/News /Default.asp. Internet. Accessed 29 September 2006.

St. Amant, Nikki. “Another Kind of ‘Birds-Eye’ View: Army Deploys CROWS to Iraq.” *The Bayonette*, 7 January 2005, 1.

Viegas, Jennifer. “New Combat Robot Prepares for Duty,” Discovery News Station-Lightning. Online article. Accessed 12 December 2006. Available from http://dsc.discovery.com/news/briefs/20041108/planebot.html. Internet.

Documents

America’s Army. “Common Remotely Operated Weapon Station” [online document]. America’s Army, accessed 14 February 2007, available from http://info.americasarmy.com/projects.php?id=10; Internet.

Frechtling, Joy, and Laure Sharp-Westat, eds. “User Friendly for Mixed Method Evaluations.” [online document] Washington, D.C.: National Science Foundation, accessed 12 December 2006, available from http://www.nsf.gov/pubs/1997/ nsf97153/. Internet.

Joint Forces Command. “Understanding the Seven Components of DOTMLPF.” Norfolk, VA: Joint Forces Command. Document online.Available from

www.teao.saic.com/cbrtraining/leveraging0.asp. Internet. accessed 16 September 2006.

Lowe, Constance. A211 Class Notes and Slides. US Army Command and General Staff College, Fort Leavenworth, KS, 7 September 2006.

Pike, John. "Common Remotely Operated Weapon Station (CROWS)." Global Security.Org. Available from http://www.globalsecurity.org/military/systems/ground/m101-crows.htm. Internet. Accessed 8 September 2006.

Raymond, William, COL. A221 Class Notes and Slides. Command and General Staff College, Fort Leavenworth, KS, 9 November 2006.

Smuda, W. J., L. Freiburger, and G. Gerhart. "Robots at War: Experiences in Iraq and Afghanistan," Research, Development, and Engineering Center, TACOM, Warren, MI. Document online. Available from http://www.ntis.gov/search/product. asp?ABBR=ADA432400. Internet. Accessed 18 December 2006;

Topolski, Chester. Presentation: Small Arms Systems Symposium, National Defense Industrial Association, 15 May 2002.

US Army Development Test Command. "Test Record for the Common Remotely Operated Weapons Station," Research, Development, and Evaluation Command, Aberdeen Proving Ground, MD, [online study results], accessed 18 October 2006, available from www.dtic.mil/ndia/2005armaments/sebasto.pdf; Internet.

US Command and General Staff College. Student Text 20-10, *Master of Military Art and Science (MMAS) Research and Thesis.* Fort Leavenworth, KS: US Army Command and General Staff College, August 2006.

US House of Representatives. House Report 109-360, National Defense Authorization Act for Fiscal Year 2006. 2005.

Electronic Messages

Cook, Wayne, Site Manager, Common Remotely Operated Weapons Station Fielding and Training Site Manager, Balad, Iraq. Electronic message to author, Ft. Leavenworth, KS.

Foster, Cris Maria, S1/Adjutant, 1st Battalion, 402nd Field Support Brigade, Balad, Iraq. Electronic message to author, Ft. Leavenworth, KS.

McKinney, Andrew, CPT. Email Correspondence with CPT Andrew McCarthy, United States Military Police Center and School, Fort Leonard Wood, MO.

Vera, Lenin, Deputy Support Operations Officer, 1st Battalion, 402nd Field Support Brigade, Balad, Iraq.

Webster, Brian, Former Site Manager, Common Remotely Operated Weapons Station Fielding and Training Site Manager, Balad, Iraq.

Other

1st Battalion, 402nd Field Support Brigade. After Action Reviews from the CROWS Fielding Office, 1st Battalion, 402nd Field Support Brigade, Balad, Iraq.

101st Airborne Division. Focus Group Feedback, MP Battalion, Fort Campbell, KY.

Association of Unmanned Vehicle Systems International. "US Military Robots Employed in Iraqi War." AUVSI Website, Arlington, VA. Available from http://www.auvsi.org/iraq/index.cfm. Internet. Accessed 13 December 2006.

US Army Force Management System. “FMS Web” [online MTOE]. Accessed 23 February 2007. Available from https://webtaads2.belvoir.army.mil/WebTAADS/tools.asp. Internet.

PEO Soldier Public Affairs Office. "PEO Soldier: The Heart of the Army-Geared to Go." Online website. Accessed 13 December 2006. Available from https://www.peosoldier.army.mil, home page. Internet.

Preston, Kenneth O. “Remarks to the Resolutions Committe.” Association of the United States Conference, Washington, D.C., 6 October 2006). Online remarks. Available from http://www.army.mil/leaders/leaders/sma/speeches/2006Oct6.html. Internet. Accessed 13 December 2006.

INITIAL DISTRIBUTION LIST

Combined Arms Research Library
US Army Command and General Staff College
250 Gibbon Ave.
Fort Leavenworth, KS 66027-2314

Dr. James Martin
Associate Dean of Academics
USACGSC
1 Reynolds Ave.
Fort Leavenworth, KS 66027-1352

LTC Prisco R. Hernandez
Reserve Components Programs
USACGSC
1 Reynolds Ave.
Fort Leavenworth, KS 66027-1352

Mr. Michael E. Weaver
Department of Logistics and Resource Operations
USACGSC
1 Reynolds Ave.
Fort Leavenworth, KS 66027-1352

CERTIFICATION FOR MMAS DISTRIBUTION STATEMENT

1. Certification Date: 15 June 2007

2. Thesis Author:

3. Thesis Title:

4. Thesis Committee Members: _____

Signatures: _____

_____

5. Distribution Statement: See distribution statements A-X on reverse, then circle appropriate distribution statement letter code below:

(A) B C D E F X SEE EXPLANATION OF CODES ON REVERSE

If your thesis does not fit into any of the above categories or is classified, you must coordinate with the classified section at CARL.

6. Justification: Justification is required for any distribution other than described in Distribution Statement A. All or part of a thesis may justify distribution limitation. See limitation justification statements 1-10 on reverse, then list, below, the statement(s) that applies (apply) to your thesis and corresponding chapters/sections and pages. Follow sample format shown below:

EXAMPLE

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
Direct Military Support (10)	/	Chapter 3	/	12
Critical Technology (3)	/	Section 4	/	31
Administrative Operational Use (7)	/	Chapter 2	/	13-32

Fill in limitation justification for your thesis below:

Limitation Justification Statement	/	Chapter/Section	/	Page(s)
	/		/	
	/		/	
	/		/	
	/		/	
	/		/	

7. MMAS Thesis Author's Signature: _____

STATEMENT A: Approved for public release; distribution is unlimited. (Documents with this statement may be made available or sold to the general public and foreign nationals).

STATEMENT B: Distribution authorized to U.S. Government agencies only (insert reason and date ON REVERSE OF THIS FORM). Currently used reasons for imposing this statement include the following:

1. Foreign Government Information. Protection of foreign information.

2. Proprietary Information. Protection of proprietary information not owned by the U.S. Government.

3. Critical Technology. Protection and control of critical technology including technical data with potential military application.

4. Test and Evaluation. Protection of test and evaluation of commercial production or military hardware.

5. Contractor Performance Evaluation. Protection of information involving contractor performance evaluation.

6. Premature Dissemination. Protection of information involving systems or hardware from premature dissemination.

7. Administrative/Operational Use. Protection of information restricted to official use or for administrative or operational purposes.

8. Software Documentation. Protection of software documentation - release only in accordance with the provisions of DoD Instruction 7930.2.

9. Specific Authority. Protection of information required by a specific authority.

10. Direct Military Support. To protect export-controlled technical data of such military significance that release for purposes other than direct support of DoD-approved activities may jeopardize a U.S. military advantage.

STATEMENT C: Distribution authorized to U.S. Government agencies and their contractors: (REASON AND DATE). Currently most used reasons are 1, 3, 7, 8, and 9 above.

STATEMENT D: Distribution authorized to DoD and U.S. DoD contractors only; (REASON AND DATE). Currently most reasons are 1, 3, 7, 8, and 9 above.

STATEMENT E: Distribution authorized to DoD only; (REASON AND DATE). Currently most used reasons are 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10.

STATEMENT F: Further dissemination only as directed by (controlling DoD office and date), or higher DoD authority. Used when the DoD originator determines that information is subject to special dissemination limitation specified by paragraph 4-505, DoD 5200.1-R.

STATEMENT X: Distribution authorized to U.S. Government agencies and private individuals of enterprises eligible to obtain export-controlled technical data in accordance with DoD Directive 5230.25; (date). Controlling DoD office is (insert).